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

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

Port of Alaska's South Floating Dock, Anchorage, Alaska

NMFS Consultation Number: AKRO-2021-01051

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?
Steller Sea Lion, Western DPS (*Eumetopias jubatus)*	Endangered	Yes	No	No	No
Humpback Whale, Western North Pacific DPS (*Megaptera novaeangliae*)	Endangered	Yes	No	No	No
Humpback Whale, Mexico DPS (*Megaptera novaeangliae*)	Threatened	Yes	No	No	No
Cook Inlet Beluga Whale (*Delphinapterus leucas)*	Endangered	Yes	No	No	No

Consultation Conducted By: National Marine Fisheries Service, Alaska Region

Issued By:

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

Date: August 9, 2021

https://doi.org/10.25923/1g8z-8a54

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

List of Tables

List of Figures

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
ADOT&PF	Alaska Department of Transportation and Public Facilities
AKBMP	Alaska Beluga Monitoring Partnership
AKR	Alaska Region
APU	Alaska Pacific University
ARRC	Alaska Railroad Corporation
AWTF	Anchorage Wastewater Treatment Facility
BA	Biological Assessment
BIA	Biologically Important Areas
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
CI	Confidence Interval
CIPL	Cook Inlet Pipeline Cross-Inlet Extension
CO_2	Carbon dioxide
CV	Coefficient of Variation
CWA	Clean Water Act
dB re 1μPa	Decibel referenced 1 microPascal
DPH	Detection Positive Hours
DPS	Distinct Population Segment
EMALL	ExxonMobil Alaska LNG
EPA	Environmental Protection Agency
ESCA	Endangered Species Conservation Act
ESA	Endangered Species Act
FR	Federal Register
ft	Feet
G&G	Geological and Geophysical
Hz	Hertz
ID	Identification
IHA	Incidental Harassment Authorization
IPCC	Intergovernmental Panel on Climate Change
ITA	Incidental Take Authorization
ITS	Incidental Take Statement

IWC	International Whaling Commission
JBER	Joint Base Elmendorf-Richardson
kHz	Kilohertz
KLU	Kitchen Lights Unit
km	Kilometers
LNG	Liquefied natural gas
MHHW	Mean Higher High Water
mi	Mile
MLLW	Mean Lower Low Water
MMPA	Marine Mammal Protection Act
MTR	Marine Terminal Redevelopment
μPa	Micro Pascal
NEPA	National Environmental Policy Act
NES	North Extension Stabilization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NRC	National Research Council
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
Opinion	Biological Opinion
OSK	Offshore Systems Kenai
Pa	Pascals
PAH	Polycyclic aromatic hydrocarbons
PAM	Passive Acoustic Monitoring
PAMP	Port of Anchorage Modernization Program
PBF	Physical or Biological Feature
PCB	Polychlorinated biphenyls
PCE	Primary Constituent Element
PCoD	Population Consequences of Disturbance
PCT	Petroleum and Cement Terminal
PDO	Pacific Decadal Oscillation
PHMSA	Pipeline and Hazardous Materials Safety Administration
PK	Peak sound level
POA	Port of Alaska
PTS	Permanent Threshold Shift
RMS	Root Mean Square

RPA	Reasonable and Prudent Alternative
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
UME	Unusual Mortality Event
UHMW	Ultra High Molecular Weight Polyethylene
USACE	U.S. Army Corps of Engineers
USFWS	United States Fish and Wildlife Services
VGP	Vessel General Permit
WFA	Weighting Factor Adjustment

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.

In this document, the action agencies are NMFS Office of Protected Resources, Permits and Conservation Division (hereafter referred to as "the Permits Division") and U.S. Army Corps of Engineers (USACE). The 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 constructing a floating dock. The USACE plans to issue a 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. This opinion replaces a 2019 letter of concurrence for the SFD provided to the USACE (NMFS # AKRO-2019-01783) (see Consultation History below). That letter of concurrence is no longer in effect.

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.

This opinion is based on information provided in the Incidental Harassment Authorization (IHA) Application CH2M (2021), the proposed IHA (86 FR 31870, June 15, 2021), and the Biological Assessment (HDR 2021). Other sources of information relied upon include updated project descriptions provided by the POA, and email and telephone conservations between NMFS Alaska Region and NMFS Permits Division staff. A complete record of this consultation is on file at NMFS's Anchorage, Alaska office.

This opinion considers the effects from the construction of the South Floating Dock (SFD) at the POA in Knik Arm, and the associated proposed issuance of an IHA on Cook Inlet beluga whales (*Delphinapterus leucas*), endangered Western North Pacific distinct population segment (DPS) humpback whales (*Megaptera novaeangliae*), threatened Mexico DPS humpback whales, endangered Western DPS Steller sea lions (*Eumetopias jubatus*), and designated critical habitat for Cook Inlet beluga whales. There is no designated critical habitat for Steller sea lions or humpback whales within the action area.

1.1. Background

The POA, located on Knik Arm in upper Cook Inlet (Figure 1), provides critical infrastructure for Alaska. The POA is modernizing its marine terminals through the Port of Alaska Modernization Program (PAMP). One component of the PAMP involves relocating the existing South Floating Dock (SFD) south of the new Petroleum and Cement Terminal (PCT) near the southern portion of the South Backlands Stabilization project. The SFD is a relatively small structure used to stage and support small vessels, such as first-responder (e.g., Anchorage Fire Department, U.S. Coast Guard) rescue craft, small work skiffs, and occasionally tugboats in an area close to the daily operations at the Port. The dock is not available to the public. The existing location of SFD will not allow docking operations at the SFD once the PCT is constructed due to the close proximity of one of the PCT mooring dolphins. PCT construction will be complete before work on the SFD begins. Relocating the SFD will involve removal of the existing structure and construction of a new dock, including installation of twelve permanent piles and six temporary piles. Plumb pile installation is expected to occur in August and September 2021. Two battered piles will be installed in October 2021. The total time needed for pile installation will be 24 days or less (Table 1).

The SFD is a relatively small structure (Figure 2) used to stage and support small vessels, such as first-responder rescue craft (e.g., Anchorage Fire Department, U.S. Coast Guard), small work skiffs, and occasionally tugboats in an area close to the daily operations at the Port. Upper Cook Inlet near Anchorage exhibits the largest tide range in the U.S. and one of the largest tide ranges in the world, with an average daily difference between high and low tide of 26.2 feet and an extreme difference of up to 41 feet. The ability of first responders to conduct response operations during low tide stages requires access to the SFD, as the waterline is inaccessible for vessels at the Anchorage public boat launch at Ship Creek during low tide stages. The planned relocation of the SFD will provide continuous access to the water, ensuring timely, safe access for rescue personnel and vessels in the northern portion of Cook Inlet.

1.2. Consultation History

May 2, 2019 – NMFS received a request from the USACE for a Letter of Concurrence incidental to pile driving associated with the construction of the South Floating Dock, as part of the Port of Alaska Modernization Program.

May 20, 2019 – NMFS received a letter from USACE that identified HDR, Inc. as the non-Federal representative for this project.

May 31, 2019 – NMFS AKR requested more information about this project by email.

June 21, 2019 – HDR, Inc. provided NMFS with additional information regarding the project schedule and proposed mitigation measures.

July 10, 2019 – NMFS initiated consultation.

July 25, 2019 – NMFS sent the USACE a Letter of Concurrence on the Port of Alaska Modernization Program—Petroleum and Cement Project Revised Application POA-2003-502-M11, Knik Arm; South Floating Dock (NMFS # AKRO-2019-01783).

October 2, 2020 – The Permits Division received a request from the POA for an IHA to take marine mammals incidental to pile driving associated with the relocation of the SFD.

October 23, 2020 – NMFS AKR received a letter from the USACE requesting reinitiation of consultation for the SFD project.

March 17, 2021 – After receiving several revisions to the IHA, the Permits Division deemed the IHA application adequate and complete.

April 2, 2021 – The Permits Division requested initiation of ESA section 7 consultation on the issuance of an MMPA IHA, for pile driving activities associated with the relocation of the Port of Alaska's South Floating Dock in Knik Arm, Alaska.

April 30, 2021 – NMFS received a Biological Assessment (BA) from the U.S. Army Corps of Engineers (USACE).

May 5, 2021 – NMFS AKR initiated ESA section 7 consultation.

June 15, 2021 – Federal Register Notice for the taking of marine mammals incidental to the relocation of the Port of Alaska’s SFD, publishes (86 FR 31870).

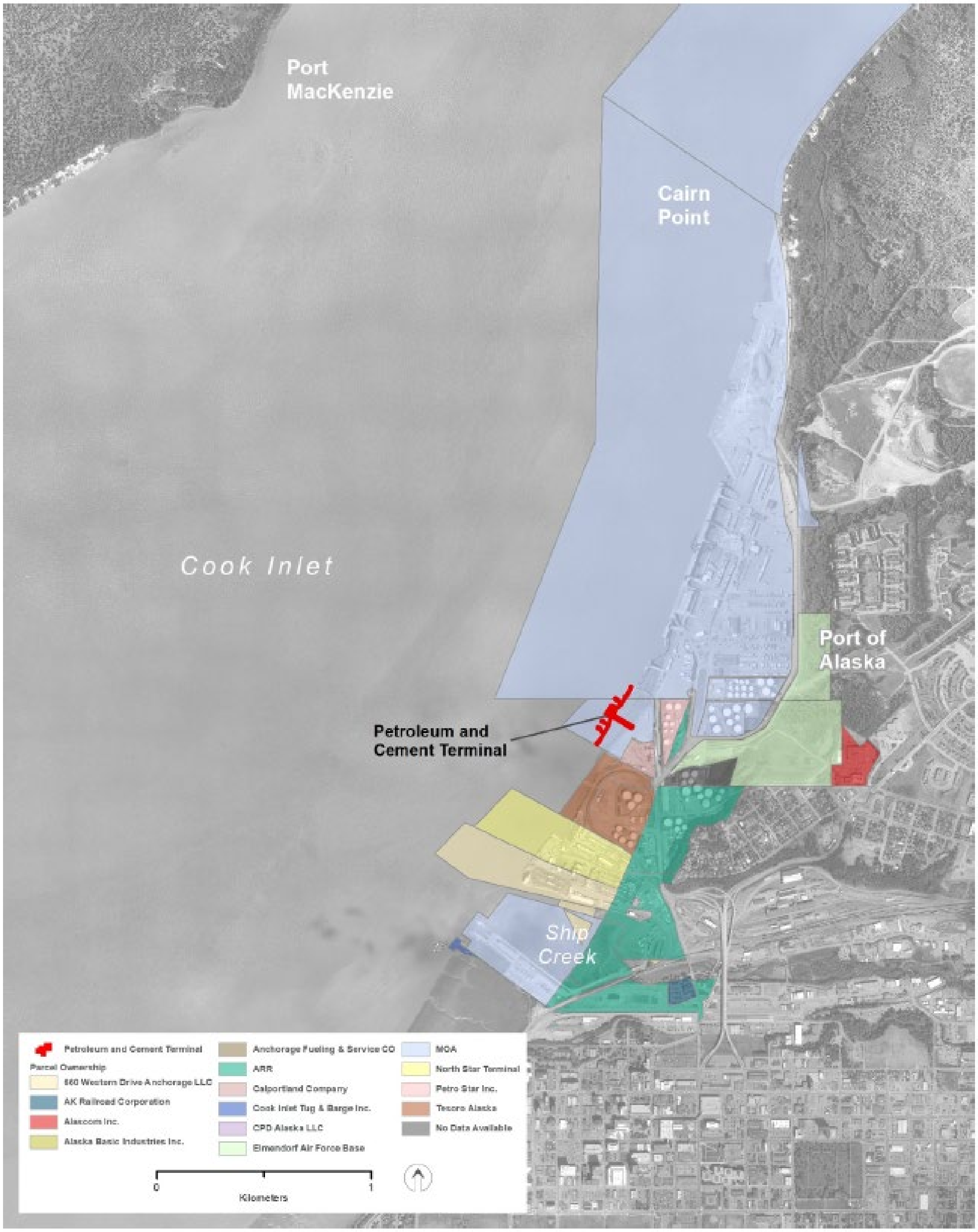

Figure 1. General location of South Floating Dock project, near the Petroleum and Cement Terminal (shown in red).

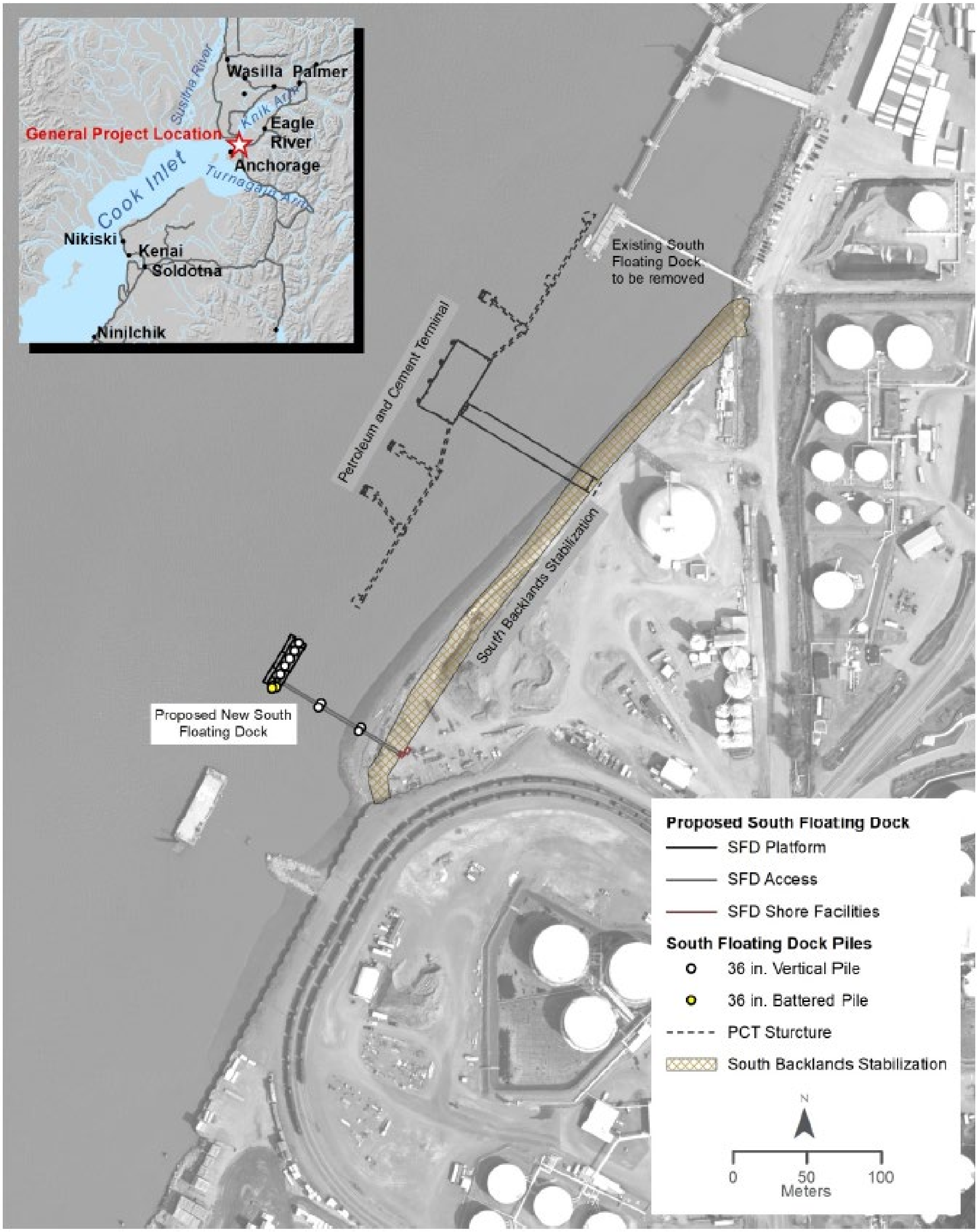

Figure 2. Existing and proposed locations for the South Floating Dock.

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. The proposed action is the authorization of construction and associated issuance of the IHA for the SFD project. The following description of the proposed action derives primarily from the IHA Application (CH2M 2021), the proposed IHA (86 FR 31870, June 15, 2021), and the Biological Assessment (HDR 2021).

2.1.1. Proposed Activities

Relocation of the SFD will include the removal of the existing structure, including the access trestle and gangway, and installation of twelve permanent 36-inch steel pipe piles: ten vertical and two battered. Construction of the SFD will also require the installation and vibratory removal of up to six 24- or 36-inch template piles. A vibratory hammer located on a floating work barge will be used to the greatest extent possible. An unconfined bubble curtain system will be used to reduce in-water noise levels for the installation of the sixteen vertical piles and removal of the six temporary piles, but will not be used during installation of the two battered piles due to the angle of these piles.

In-water pile installation and removal associated with SFD removal and construction is expected to require up to 24 nonconsecutive days. Work is expected to begin in the summer or fall of 2021. Installation of permanent and temporary piles is expected to take 45 minutes per pile with 1-3 piles being installed per day over 7-18 days (Table 1). Removal of six temporary piles is expected to take 75 minutes per pile with 1-3 piles being removed per day over 2-6 days. All pile-driving will occur during daylight hours.

An impact hammer may be required if a pile encounters refusal and cannot be advanced to the necessary tip elevation with the vibratory hammer. Refusal criteria for a vibratory hammer is defined by the hammer manufacturer and is described as the pile not advancing one foot within 30 seconds of vibratory hammer operation at full speed. Three piles have deeper embedment depth than others, and therefore may reach refusal before the specified minimum tip elevation. In such a situation, an impact hammer would be needed to drive these piles to their required depth. A small number of total piles, estimated up to five piles, may reach refusal before the tip elevation is reached, requiring up to 20 minutes of impact installation each at one pile per day. POA estimates that each of these piles could require up to 1,000 strikes, which was the mean number of strikes measured for 48-inch production piles during the PCT Phase 1 construction sound source verification (SSV) study (Reyff et al. 2021). It is likely that the number of strikes will be less due to the smaller pile sizes associated with SFD. However, to be conservative, we assume 1,000 strikes will be needed. It is assumed that if a pile requires impact installation, the vibratory installation time would be reduced by a commensurate amount (i.e., 15 minutes of impact installation would replace 15 minutes of vibratory installation), and the overall duration of installation would remain the same.

Temporary template piles (n = 6) will be removed with a vibratory hammer (Table 1). Based on an analysis of PCT Phase 1 data, each temporary pile will require approximately 75 minutes of vibratory hammer removal. Knik Arm soils have demonstrated a strong set up and resistance condition on temporary piles due to dense clay composition, making removal lengthier and more difficult than installation. The temporary piles for the SFD will be in place approximately three weeks and will not be load-bearing, in contrast to the piles used for the PCT temporary trestle that were in place for approximately five months and subject to loads from the construction crane. It is therefore estimated that the temporary SFD piles will require less time for removal than PCT piles. The estimated removal time is approximately two-thirds of the duration required for vibratory removal of 36-inch temporary trestle piles during PCT Phase 1 construction. The existing SFD float and gangway piles will remain in place; a vibratory hammer will not be required for their removal.

The POA will use an unconfined bubble curtain noise attenuation system to mitigate noise propagation during vibratory installation and potential impact installation of the ten permanent plumb piles and six temporary plumb piles, and vibratory removal of the six temporary piles when water depth is deep enough to deploy a bubble curtain (approximately 3 m). A 7 dB reduction in sound level will be applied when the bubble curtain is used (U.S. Navy 2015). Pile installation or removal in the dry, which is a completely de-watered state, is unlikely but if it occurs, will be conducted without a bubble curtain. A bubble curtain will not be used with the two battered piles due to the angle of installation that is required.

Tugboats and floating barges, which are used regularly as part of standard POA operations, and which are already onsite, will be used in support of the SFD construction. No large vessel traffic through Cook Inlet is associated with this project.

Table 2. Pile Details and Estimated Effort Required for Pile Installation and Removal

Pipe Pile Diameter	**Feature**	**Number of Plumb Piles**	**Number of Battered Piles**	**Vibratory Installation Duration Per Pile (minutes)**	**Vibratory Removal Duration Per Pile (minutes)**	**Potential Impact Strikes per Pile, if Needed (up to 5 piles)**	**Production Rate (piles/day)**		**Days of Installation**	**Days of Removal**
							Installation	**Removal**		
36-inch	Floating Dock	6	2	45	n/a	1,000	1-3	n/a	4-12	n/a
	Gangway	4	0		n/a	1,000	1-3	n/a		n/a
24- or 36-inch	Temporary Template Piles	6	0	45	75	1,000	1-2	1-3	3-6	2-6
Project Totals		**16**	**2**	**13.5 hours**	**7.5 hours**		**--**	**--**	**7-18 days**	**2-6 days**

2.1.2. Mitigation Measures

The following mitigation measures are also outlined in the Permits Division's proposed IHA for the South Floating Dock (86 FR 31870; June 15, 2021) project and are part of the Marine Mammal Monitoring and Mitigation Plan submitted by the POA (POA 2021).

Definitions

Two terms that are introduced in this section are 'shutdown' zone and 'harassment' zone. If a marine mammal enters or is on a trajectory that will take it into a shutdown zone when construction activities are occurring, pile driving and/or other construction activities must stop as quickly as possible. The harassment zone is the area in which a shutdown won't necessarily occur because take has been authorized. Under the terms of the IHA and this BiOp, a few listed marine mammals can enter this zone and be taken (harassed) (See Section 10.1 Amount or Extent of Take). For Cook Inlet beluga whales, the project's harassment zone equals the shutdown zone; Steller sea lions and humpback whales could enter the harassment zone and a shutdown is not required unless they are approaching or entering their designated shutdown zones (Table 2). Details for the calculation of the zones is provided in Section 6.3.3 Area of Ensonification.

The terms Level A and Level B harassment are terms used under the MMPA and refer to the severity of harassment a marine mammal could be exposed to. Level A harassment indicates that a permanent hearing loss or other types of non-serious injury could occur. Level B harassment includes behavioral disturbance or temporary hearing loss (See Section 6.2 Exposure and Response Analysis for more details).

Mitigation Measures

1. Pile driving will occur during daylight hours only.
2. POA will conduct briefings for construction supervisors and crews, the monitoring team, and POA staff prior to the start of all pile driving activity, and when new personnel join the work, in order to explain responsibilities, communication procedures, the marine mammal monitoring protocol, and operational procedures.
3. POA will employ PSOs per the Marine Mammal Monitoring Plan and Monitoring Measures described beginning with #18 below.
4. Marine mammal monitoring will take place from 30 minutes prior to initiation of pile installation and removal through 30 minutes post-completion of pile driving. Pile driving may commence when observers have declared the shutdown zones described in Table 2 clear of marine mammals or the beluga whale mitigation measures (#7) are satisfied. In the event of a delay or shutdown of activity resulting from marine mammals, animals must be allowed to leave on their own volition and their behavior must be monitored and documented.

5. If PSO monitoring ceases, but pile driving is scheduled to resume, PSOs must follow pre-pile driving monitoring protocol as described in mitigation measure 4 above.
6. If a marine mammal appears likely to enter or is observed within an established shutdown zone (Table 2), pile driving must be halted or delayed. Pile driving will not commence or resume until either the animal has voluntarily left and been visually confirmed 100 m beyond the shutdown zone and on a path away from such zone or 15 minutes (non-beluga beluga whales) or 30 minutes (beluga whales) have passed without subsequent detections.

Table 3. Level B, monitoring, and shutdown zones by pile size and pile driving method for installation of piles.[1]

Pile Size	Hammer Type	Attenuation	Level B Harassment Zone (Monitoring Zone) radius (m)	Humpback Whale Shutdown Zone (m)	Steller Sea Lion Shutdown Zone radius (m)	Beluga Whales Shutdown Zone radius (m)
36-in	Impact	Unattenuated	1,848	1,165	100	1,848
	Vibratory		8,318	100		8,318
	Impact	Bubble curtain	631	398		631
	Vibratory		4,106	100		4,106
24-in	Impact		542	251		542
	Vibratory		2,631	100		2,631
	Impact	Unattenuated	1,585	735		1,585
	Vibratory		3,861	100		3,861

1. A similar Table is provided in the PCT biological opinion (Table 5) (NMFS 2020). It provides a single distance of 100 m for "Non- Beluga Whales" and no distinction was made for Steller sea lions. However, as is the case here, there are different shutdown zone sizes for humpback whales depending on the activity. Those zones were calculated and were available in Table 19 of the PCT biological opinion but the zone sizes were not extracted and presented as we have done here.

7. Cook Inlet Beluga Whales Pile Driving Delay/Shutdown Protocol
    i. Prior to the onset of pile driving or removal, should a beluga whale(s) be observed swimming toward or into lower Knik Arm, pile installation or removal will be delayed (Figure 3). Pile driving will not commence until either the animal has voluntarily traveled at least 100 m beyond the Level B harassment zone (Table 2) or has not been re-sighted within 30 minutes.
    ii. If pile installation or removal has commenced, and a beluga whale(s) is observed within or likely to enter the Level B harassment zone (Table 2), a PSO will call for a shutdown. Pile driving will shut down and will not re-commence until the beluga whale is out of and on a path away from the Level B harassment zone (Table 2) or

until no beluga whale has been observed in the Level B harassment zone (Table 2) for 30 minutes immediately prior to resumption of pile driving.

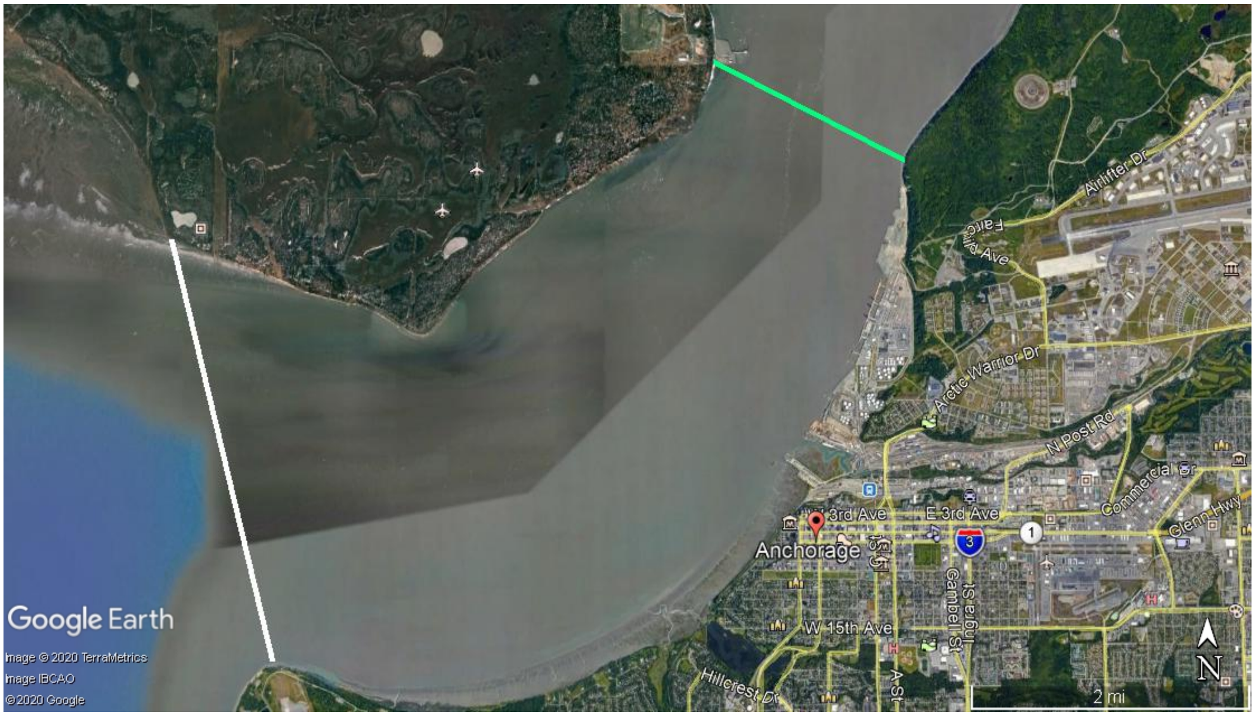

Figure 3. Boundaries of the pre-pile driving clearance zone.

8. If PSOs can no longer effectively monitor all waters within the Level B harassment zone (Table 2) for the presence of marine mammals due to environmental conditions (e.g., fog, rain, wind), pile driving will continue only until the current segment of pile is driven; no additional sections of pile or additional piles will be driven until conditions improve such that the Level B harassment zone can be effectively monitored. If monitoring of the Level B harassment zone has been interrupted for 30 minutes or more, the entire Level B harassment zone will be observed again and determined to be clear of marine mammals for 30 minutes prior to pile driving following the protocol outlined in measure 4.
9. POA will use soft start techniques when impact pile driving. 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 will 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.
10. The POA will use a bubble curtain during impact and vibratory pile driving for all plumb (i.e., vertical) piles installed in > 3 m of water. The bubble curtain will be operated as necessary to achieve optimal performance. The final design of the bubble curtain will be

determined by the Construction Contractor based on factors such as water depth, current velocities, and pile sizes. However, the proposed IHA requires the bubble curtain be operated in a manner consistent with the following performance standards:

i. The bubble curtain must distribute air bubbles around 100 percent of the piling circumference for the full depth of the water column.

ii. The lowest bubble ring must be in contact with the substrate for the full circumference of the ring, and the weights attached to the bottom ring shall ensure 100 percent substrate contact. No parts of the ring or other objects shall prevent full substrate contact.

iii. Air flow to the bubblers must be balanced around the circumference of the pile.

iv. The aeration pipe system will consist of multiple layers of perforated pipe rings, stacked vertically in accordance with the following depths: two layers for water depths < 5 m; four layers for water depths 5 m to < 10 m; seven layers for water depths 10 m to < 15 m; ten layers for water depths 15 m to < 20 m; and thirteen layers for water depths 20 m to < 25 m.

v. The pipes in all layers will be arranged in a geometric pattern that will allow for the pile being driven to be completely enclosed by bubbles for the full depth of the water column and with a radial dimension such that the rings are no more than 0.5 meter from the outside surface of the pile.

vi. The lowest layer of perforated aeration pipe will be designed to ensure contact with the substrate without burial and will accommodate sloped conditions.

vii. Air holes will be 1.6 millimeters (1/16 inch) in diameter and will be spaced approximately 20 millimeters (3/4 inch) apart. Air holes with this size and spacing will be placed in four adjacent rows along the pipe to provide uniform bubble flux.

viii. The system will provide a bubble flux of 3 cubic meters per minute per linear meter of pipe in each layer (32.91 cubic feet per minute per linear foot of pipe in each layer). The total volume of air per layer is the product of the bubble flux and the circumference of the ring using the formula: $V_t = 3.0\ m^3/min/m$ * Circumference of the aeration ring in meters or $V_t = 32.91\ ft^3/min/ft$ * Circumference of the aeration ring in feet.

ix. Meters must be provided as follows:

   A. Pressure meters must be installed at all inlets to aeration pipelines and at points of lowest pressure in each branch of the aeration pipeline.

   B. Flow meters must be installed in the main line at each compressor and at each branch of the aeration pipelines at each inlet. In applications where the feed line from the compressor is continuous from the compressor to the aeration pipe inlet, the flow meter at the compressor can be eliminated.

C. Flow meters must be installed according to the manufacturer's recommendation based on either laminar flow or non-laminar flow.

11. When piles are installed or removed in water without a bubble curtain (e.g. battered pile or water is ≤ 3 m) the unattenuated Level A and Level B harassment zones for that hammer type and pile size will be implemented.
12. Vibratory driving of the unattenuated battered piles will not occur during August or September.
13. POA will not install unattenuated plumb piles in water depths greater than 3 meters.
14. POA will not operate two vibratory hammers concurrently.
15. Construction supervisors and crews, PSOs, and relevant POA staff will avoid direct physical interaction with marine mammals during construction activity. If a marine mammal comes within 10 meters of such activity, operations will cease.
16. For in-water construction, heavy machinery activities other than pile driving (e.g., use of barge-mounted excavators, dredging), if a marine mammal comes within 10 m, POA will cease operations and reduce vessel speed to the minimum level required to maintain steerage and safe working conditions.
17. If a species for which take authorization has not been granted, or a species for which take authorization has been granted but the authorized takes are met, is observed approaching or within the monitoring zone (Table 2), pile driving and removal will shut down immediately. Pile driving will not resume until the animal has been confirmed to have left the area or the 30- minute observation period has elapsed.

Monitoring Measures

18. Marine mammal monitoring will be conducted in accordance with the Marine Mammal Monitoring Plan (Appendix A of POA 2021) and the following measures:
    i. PSOs will be positioned at four stations during all pile driving to maximize marine mammal detection: one station will be at the SFD site, one at Ship Creek, one at Point Woronzof or nearby location, and one location north of the SFD site (e.g., northern end of POA, Port MacKenzie).
    ii. PSOs will work in three- to four-person teams at each outer (northern and southern) observation station. The station at the project site will have at least two PSOs. At least two PSOs will be on watch at any given time at each station. A third PSO will be available to record data at the southern and northern stations.
    iii. Each outer (southern and northern) station must be equipped with large-aperture binoculars (25X), hand-held binoculars (at least 7X), and range finders. A

theodolite must be available at one station. The central station must be equipped with hand-held binoculars (at least 7X) and range finders.

19. Marine mammal monitoring during pile driving and removal will be conducted by NMFS-approved PSOs in a manner consistent with the Marine Mammal Monitoring Plan and the following:

    i. Independent PSOs (*i.e*., not construction personnel) who have no other assigned tasks during monitoring periods must be used.

    ii. A lead observer or monitoring coordinator must be designated. The lead observer must have prior experience working as a marine mammal observer during construction.

    iii. Other PSOs may substitute other relevant experience, education (degree in biological science or related field), or training for prior experience performing the duties of a PSO during construction activity pursuant to a NMFS-issued incidental take authorization.

    iv. POA must submit PSO CVs for approval by NMFS prior to the onset of pile driving.

    v. 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.

    vi. A PSO must observe for no more than 4 hours at a time, with at least a one-hour break between shifts, and no more than 12 hours on duty per day.

20. PSOs will have the following additional qualifications:

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

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

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

    iv. Ability to observe and record environmental and marine mammal sighting data, 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.

    v. 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 will record all observations of marine mammals, regardless of distance from the pile being driven as well as additional data indicated in #25 below.

Reporting

The POA will:

22. Submit monthly marine mammal monitoring reports, including data sheets, during the SFD construction season. These reports must include a summary of marine mammal species and behavioral observations, pile driving shutdowns or delays, and pile work completed.
23. Alert NMFS (Table 3) when the number of Cook Inlet beluga whale takes reaches 80 percent of those authorized. Weekly marine mammal monitoring reports will assist with the tracking of take numbers.
24. 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:
    i. Dates and times (begin and end) of all marine mammal monitoring.
    ii. Construction activities occurring during each daily observation period, including how many and what type of piles were driven or removed and by what method (*i.e.*, impact or vibratory).
    iii. Weather parameters and water conditions during each monitoring period (*e.g.,* wind speed, percent cover, visibility, sea state).
    iv. The number of marine mammals observed, by species, relative to the pile location and if pile driving or removal was occurring at time of sighting.
    v. Age and sex class, if possible, of all marine mammals observed.
    vi. PSO locations during marine mammal monitoring.
    vii. Distances and bearings of each marine mammal observed to the pile being driven or removed for each sighting (if pile driving or removal was occurring at time of sighting).
    viii. Description of any marine mammal behavior patterns during observation, including direction of travel.
    ix. Number of individuals of each species (differentiated by month as appropriate) detected within the monitoring zone, and estimates of number of marine mammals taken, by species (a correction factor may be applied to total take numbers, as appropriate).

x. 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.

xi. 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.

25. Reporting injured or dead marine mammals:

i. In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner not authorized in this opinion or the IHA, such as serious injury, or mortality, POA must immediately cease the specified activities and report the incident to the NMFS Office of Protected Resources (301-427-8401) and Alaska Region Stranding Hotline (1-877-925-7773) (Table 3). Activities will 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 compliance. POA may not resume their activities until notified by NMFS. The report of the incident must include the following information:

1. Time and date of the incident;
2. Description of the incident;
3. Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility);
4. Description of all marine mammal observations and active sound source use in the 24 hours preceding the incident;
5. Species identification or description of the animal(s) involved;
6. Fate of the animal(s); and
7. Photographs or video footage of the animal(s).

ii. In the event POA discovers an injured or dead marine mammal, and the lead observer determines that the cause of the injury or death is unknown and the death is relatively recent (*e.g.,* in less than a moderate state of decomposition), POA must immediately report the incident to the NMFS Office of Protected Resources and the NMFS AKR Stranding Hotline (877-925-7773). The report must include the same information identified in mitigation measure 25(i) of this opinion. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with POA to determine whether additional mitigation measures or modifications to the activities are appropriate.

iii. In the event that POA discovers an injured or dead marine mammal, and the lead observer determines that the injury or death is not associated with or related to the specified activities (*e.g.*, previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), POA must report the incident to the NMFS Office of Protected Resources, and the Alaska Region Stranding Hotline (877-925-7773) within 24 hours of the discovery.

Summary of Agency Contact Information

Table 4. Summary of agency contact information.

Reason for Contact	Contact Information
Alaska Regional Office (AKR) - ESA Consultation Questions, Reports & Data Submittal	Greg Balogh: greg.balogh@noaa.gov, 907-271-3023 Marilyn Myers marilyn.myers@noaa.gov Bonnie Easley-Appleyard: bonnie.easley-appleyard@noaa.gov; 907-271-5172
Office of Protected Resources (OPR) – ITR/MMPA Questions, Report & Data Submittal	Jolie Harrison (Jolie.Harrison@noaa.gov) Jaclyn Daly (jaclyn.daly@noaa.gov)
Stranded, Injured, or Dead Marine Mammal	Stranding Hotline (24/7 coverage) 877-925-7773
Note: In the event that this contact information becomes obsolete please call NMFS Anchorage Main Office 907-271-5006	

2.2. Action Area

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

NMFS defines the action area for this project as the area within which project-related noise levels are ≥122.2 dB_{rms} re 1µPa or approaching ambient noise levels (i.e., the point where no measurable effect from the project would occur; see Section 6.3.2).[1] To define the action area, we considered the maximum diameter and type of piles, the pile-driving methods (i.e., with and without bubble curtains), and empirical measurements of noise. Received sound levels associated with vibratory pile driving of the 36-in diameter battered piles are anticipated to decline to 122.2 dB_{rms} re 1µPa within 8,318 meters of the source (Figure 4), see the Acoustic Thresholds section 6.3.2 for more information on the factors included in this calculation.

[1] We express noise as 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) expressed in root mean square (rms), which is the square root of the arithmetic average of the squared instantaneous pressure values.

Figure 4. South Floating Dock action area (outlined in red).

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).

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

We 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 rangewide status of the species and critical habitat likely to be adversely affected by the proposed action. This section describes the current status of each listed species and its critical habitat relative to the conditions needed for recovery. We determine the rangewide status of critical habitat by examining the condition of its PBFs - which were identified when the critical habitat was designated. Species and critical habitat status are discussed in Section 4 of this opinion.
- Describe the environmental baseline including: past and present impacts of Federal, state, or private actions and other human activities in the action area; expected impacts of proposed Federal projects that have already undergone formal or early section 7 consultation, and the impacts of state or private actions that are contemporaneous with

the consultation in process. The Environmental Baseline is discussed in Section 5 of this opinion.

- Analyze the effects of the proposed actions. Identify the listed species that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our exposure analyses). In this step of our analyses, we identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to stressors and the populations or subpopulations those individuals represent. NMFS also evaluates the proposed action's effects on critical habitat features. The stressors and effects of the action are described in Section 6.
- 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 Sections 6.2.1 through 6.2.4.
- Describe any cumulative effects. Cumulative effects, as defined in NMFS's implementing regulations (50 CFR § 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation. Cumulative effects are considered in Section 7 of this opinion.
- Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat. In this step, NMFS adds the effects of the action (Section 6) to the environmental baseline (Section 5) and the cumulative effects (Section 7) to assess whether the action could reasonably be expected to: (1) appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat (Section 4). Integration and synthesis with risk analyses occurs in Section 8 of this opinion.
- Reach jeopardy and adverse modification conclusions. Conclusions regarding jeopardy and the destruction or adverse modification of critical habitat are presented in Section 9. These conclusions flow from the logic and rationale presented in the Integration and Synthesis Section 8.
- If necessary, define a reasonable and prudent alternative to the proposed action. If, in completing the last step in the analysis, NMFS determines that the action under consultation is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, NMFS must identify a reasonable and prudent alternative (RPA) to the action.

4. Rangewide Status of the Species and Critical Habitat

Three species (four DPSs) of marine mammals listed under the ESA under NMFS's jurisdiction may occur in the action area. The action area also includes designated critical habitat for Cook Inlet beluga whales. This opinion considers the effects of the proposed action on these species and designated critical habitat (Table 4). The nearest designated critical habitat for the Steller sea lion is over 200 km from the action area. Likewise the nearest critical habitat for the Western North Pacific DPS humpback of whales is over 200 km from the action area (Muto et al. 2020). Critical habitat for the Mexico DPS is even farther away.

Table 5. Listing status and critical habitat designation for marine mammals considered in this opinion.

Species	Status	Listing	Critical Habitat
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
Cook Inlet beluga whale (*Delphinapterus leucas*)	Endangered	NMFS 2008, 73 FR 62919	NMFS 2011, 76 FR 20180
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. 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 the probability of a 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 would not be exposed to any of the stressors expected from this proposed project. Cook Inlet beluga whale critical habitat will be exposed to stressors from the proposed project but we have determined that the stressors are not likely to adversely affect Cook Inlet beluga whale critical habitat.

Cook Inlet beluga whale critical habitat is within the action area (Figure 10 and Figure 11). As discussed in Section 4.3.1.7 (*Cook Inlet Beluga Whale Critical Habitat*), Knik Arm is Area 1 habitat for the Cook Inlet beluga whales, which means it is the most valuable, used intensively by beluga whales from spring through fall for foraging and nursery habitat. However, the POA, the adjacent navigation channel, and the turning basin were excluded from critical habitat designation due to national security concerns (76 FR 20180, April 11, 2011). 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 Cairn Point is likely to impede any pile driving noise from propagating into northern Knik Arm (Eagle River flats).

The following describes the potential effects of the proposed SFD project on designated Cook Inlet beluga whale critical habitat (50 CFR § 226.220(c)). Section 4.3.1.7 describes the geographical extent and Physical and Biological Features (PBFs) of designated Cook Inlet Beluga Whale Critical Habitat. NMFS has determined that the only stressors from the proposed action that may affect Cook Inlet beluga critical habitat are the following: noise from pile driving activities, disturbance to the seafloor, turbidity, and possible accidental release of pollutants. The effects of these stressors on each of the PBFs is 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 underpinnings of PBF1 rest on the importance of the shallow water channel morphology and mudflats that are present at the mouths of Cook Inlet anadromous streams for the concentration of prey into narrow channels and potential protection from killer whales (74 FR 63080). Although there are several medium or high flow anadromous streams and their associated intertidal and subtidal waters that occur within the action area, the effects of the pile driving within POA and project related vessel traffic are not expected to affect the bathymetry or hydrology of the anadromous streams or their channels, or to alter their function in concentrating prey or providing protection from killer whales. 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 within designated essential fish habitat (EFH) for chum salmon (*Oncorhynchus keta*), coho salmon (*Oncorhynchus kisutch*), Chinook salmon (*Oncorhynchus tshawytscha*), and pink salmon (*Oncorhynchus gorbuscha*). Other managed groundfish species (Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole) may occur within the area during early life stages. Potential impacts to PBF2 include increased turbidity, elevation in noise levels during pile driving, and small spills. As described in Section 6.6.3 (*Sea Floor Disturbance and Turbidity)*, pile installation may temporarily increase turbidity resulting from suspended sediments. POA must comply with state water quality standards during these operations by limiting the extent of turbidity to the immediate project area. In general, turbidity associated with pile installation is localized to about a 25-foot (7.6 m) radius around the pile (Everitt et al. 1980). In addition, the waters of upper Cook Inlet are naturally very turbid and the extreme tidal exchanges will rapidly disperse any localized increase in suspended sediments. Therefore, any increases in turbidity are expected to be temporary, localized, and have no measurable impacts to prey species.

As discussed in Section 6.6.2 fish may respond to noise associated with the proposed action by avoiding the immediate area. However, the impact of noise on beluga prey is expected to be very minor, and thus adverse effects to PBF2 will be immeasurably small. Fish may be disturbed by presence of vessels, or struck, but due to the slow speed of the project vessels, and the localized presence of vessels near the POA, we expect that disturbance and vessel strike of fish are very unlikely to occur.

In addition to noise effects on prey, 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. We expect no measurable project-related changes in primary prey population levels, distribution, or availability to belugas. The probability of a spill adversely affecting prey species is very small, and if small spills occur the adverse effects to PBF2 would 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. However, an accidental small spill could occur. Chronic exposure to small spills could affect individual whales within their lifetime through accumulation of contaminants, which can affect complex biochemical pathways that suppress immune functions and disrupt the endocrine balance of the body, causing poor growth, development, reproduction, and reduced fitness (Geraci 1990; Geraci and St. Aubin 1990).

As discussed in Section 6.6.5 (Pollutants and Contaminants), authorized discharges of pollutants are regulated through NPDES permits, which undergo separate ESA section 7 consultations (NMFS 2010b). As discussed in PBF 2 and in the Pollutants and Contaminants section, unauthorized small spills are expected to rapidly disperse due to tide-induced currents, turbulence, and mixing. Because of the short duration of this project, the limited use of vessels, and the fact that no handling of toxins outside of normal operating procedures for vessels (e.g. fueling) is expected, the probability of a small spill is very small. For these reasons we expect no project-related measurable change in primary prey in terms of prey population levels, distribution, or availability to Cook Inlet beluga whales as a consequence of toxins or other harmful agents.

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

PBF 4 may be affected by noise from pile driving activities. Cook Inlet beluga whales are unlikely to be physically restricted from passing through critical habitat. Section 6.5.1 discusses the effects of noise on belugas and the potential for noise to restrict passage between critical habitat areas. Beluga avoidance of ensonified areas has the potential to restrict their passage from one critical habitat area to another; however, Cook Inlet belugas continued to pass by the POA during previous pile driving, other construction activities, and dredging at the POA (Kendall and Cornick 2015; Kendall et al. 2014; POA 2019; USACE 2019). Based on their reactions during prior similar activities, we expect Cook Inlet belugas will continue to pass by the POA during project activities associated with this proposed action. In addition, we expect the mitigation measures (2.1.2 Mitigation Measures) to be effective in avoiding restrictions to passage through the action area during pile driving. Pile driving will stop when belugas are seen approaching the Level B harassment zone and will not resume until they have left the zone.

We note that the maximum amount of pile driving that may occur in one day (if 3 piles were driven and it takes an estimated 45 minutes for each) is two hours and 15 minutes (Table 1). However, for Phase 2 of the PCT, the average amount of time it took to drive the 36” piles (n=6) was 11.3 minutes. This information indicates that the estimated amount of time for pile driving for this project is very conservative (45 minutes/pile) and the amount of pile driving that will occur on any given day will likely be much less than one hour, even if three piles are driven in one day (an unlikely event based on prior POA projects). The limited amount of potential exposure in combination with the mitigation measures leads us to conclude that any effects on passage would 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.

It is evident that the commonly used portion of historical range of Cook Inlet beluga whales has contracted and is currently concentrated in the upper portion of the inlet. However, instead of remaining in the quietest habitats available, the belugas continue to occupy the busiest and nosiest habitat available, presumably because the best foraging opportunities are available in Upper Cook Inlet. Due to the industrial activity, development, and vessel traffic in Cook Inlet beluga critical habitat, a wide variety of anthropogenic noise sources are present. Although anthropogenic noise is present year-round, many sources of anthropogenic noise are seasonal and occur during the ice-free months. Sources include vessel noise from tugs, tankers, cargo ships, fishing vessels, small recreational vessels, dredging, pile-driving, military detonations, and seismic surveys (NMFS 2016b). In spite of the current in-water noise levels critical habitat has not been abandoned in Upper Cook Inlet.

Pile driving will result in underwater noise in critical habitat. As discussed below (6.5.1), abandonment of habitat during periods of construction noise has been seen in other marine mammals (Forney et al. 2017; Wartzok et al. 2003). However, as also discussed in Section 6.5.1, Cook Inlet beluga whales have continued to use Knik Arm through previous periods of pile driving, dredging, and other construction activities at the POA. Additionally, the implementation of mitigation measures (bubble curtains, pile driving shutdown zones) will reduce the impact of in-water noise on Cook Inlet belugas in the POA area, and the likelihood of temporary avoidance of the area. As discussed in PBF4 the amount of time in which critical habitat will be ensonified on any given day is likely less than one hour and protected species observers will be on duty to stop pile driving if belugas head towards the ensonified areas allowing the belugas to pass through the action area without exposure to pile driving sound. Beluga whales may avoid portions of the action area during construction, but based on historical patterns we expect they would resume using those habitat areas, and thus we expect the effects on PBF5 will be immeasurably small.

In summary, NMFS concurs that activities associated with the proposed SFD project are not likely to adversely affect Cook Inlet beluga whale critical habitat. Beluga whales may choose to not forage in close proximity to the SFD site during pile driving, however, the POA is excluded from critical habitat and is not an important foraging location for the belugas. Project stressors will have no effect on PBF 1. While some stressors are unlikely to occur, the remaining project stressors will have immeasurably small effects on PBFs 2, 3, 4, and 5. Project stressors are extremely unlikely to cause abandonment of critical habitat (PBF 5).

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 that follow. 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 in general, and in the Arctic specifically:

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

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

http://nsidc.org/arcticseaicenews/

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

Air temperature

Three facets of climate change, increased air temperatures, increased ocean temperatures, and ocean acidification are presented because they have the most direct impact on marine mammals. The decadal global land and ocean surface average temperature anomaly for 2011–2020 indicates that it was the warmest decade on record for the globe, with a surface global temperature of +0.82°C (+1.48°F) above the 20th century average[2]. This surpassed the previous decadal record (2001–2010) value of +0.62°C (+1.12°F)[3]. The 2020 Northern Hemisphere land and ocean surface temperature was the highest in the 141-year record at +1.28°C (+2.30°F) above average. This was 0.06°C (0.11°F) higher than the previous record set in 2016[2].

Since 2000, the Arctic (latitudes between 60ºN and 90ºN) has been warming at more than two times the rate of lower latitudes because of “Arctic amplification,” a characteristic of the global climate system influenced by changes in sea ice extent, atmospheric and oceanic heat transports, cloud cover, black carbon, and many other factors[4] (Overland et al. 2017; Serreze and Barry 2011) and the average annual temperature is now 3-4° F warmer than during the early and mid-century (Thoman and Walsh 2019) (Figure 5). The statewide average annual temperature in 2020 was 27.5°F, 1.5°F above the long-term average even though it was the coldest year since 2012[5].

[2] https://www.ncdc.noaa.gov/sotc/global/202013 viewed on 5/31/2021
[3] https://www.ncdc.noaa.gov/sotc/global/202013 viewed on 5/31/2021
[4] NASA wepbage. State of the Climate: How the World Warmed in 2019. Available at https://www.carbonbrief.org/state-of-the-climate-how-the-world-warmed-in-2019, accessed January 20, 2020.
[5] https://www.ncdc.noaa.gov/sotc/national/202013 viewed on 5/31/2021

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).

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 (Cheng et al. 2020; IPCC 2019). The upper ocean heat content, which measures the amount of heat stored in the upper 2000 m (6,561 ft) of the ocean, was the highest on record in 2019 by a wide margin and is the warmest in recorded human history (Cheng et al. 2020).

The seas surrounding Alaska have been unusually warm in recent years, with unprecedented warmth in some cases (Thoman and Walsh 2019). This effect can be seen throughout the Alaska region, including the Bering, Chukchi, and Beaufort seas (Figure 6). Along the west coast, the surface waters were 4–11ºF warmer than average in the summer of 2019 (Thoman and Walsh 2019).

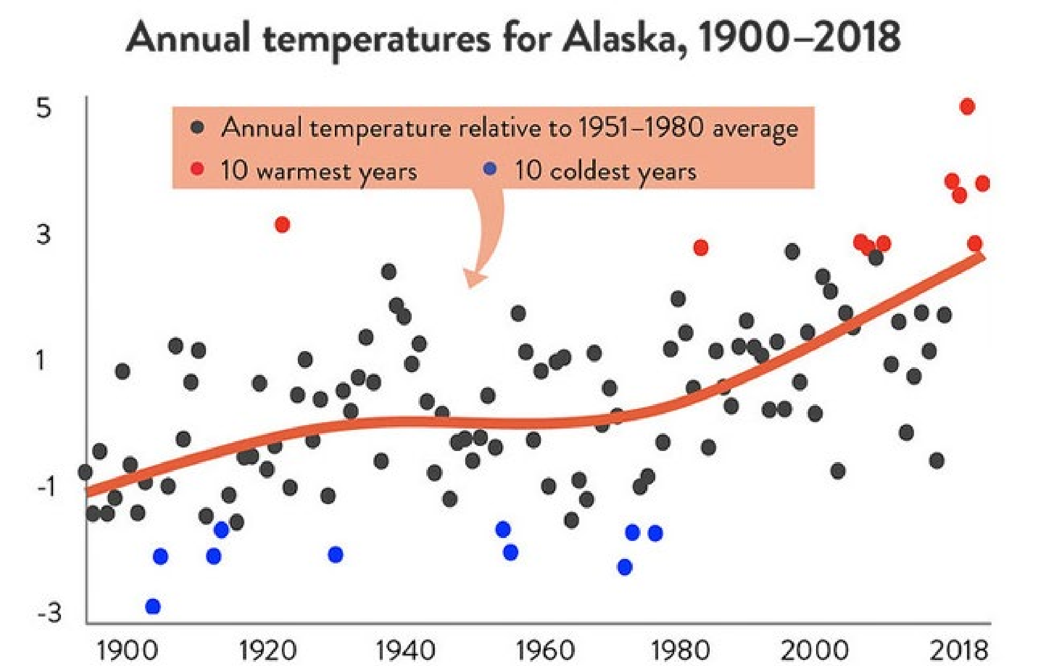

Figure 5. Alaska's ten coldest years on record (blue dots) all occurred before 1980. Nine of its ten warmest years on record have occurred since 1980. Graph by Rick Thoman, Alaska Center for Climate Assessment and Policy.

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 (i.e., September sea ice extent) began declining at an accelerated rate and continues to decline at a rate of approximately minus 2.7

percent per decade (Stroeve et al. 2007; Stroeve and Notz 2018). Although Arctic sea ice loss has been well documented, the seasonal ice cover in Cook Inlet has not been characterized in as much detail, but we expect that the same general trend of later ice formation and earlier melt occurs in that body of water as well. Of the three species we are considering in this biological opinion, beluga whales would be most affected by changing ice conditions in Cook Inlet because their entire life is spent in this single body of water. How changing patterns of ice may affect belugas remains speculative.

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

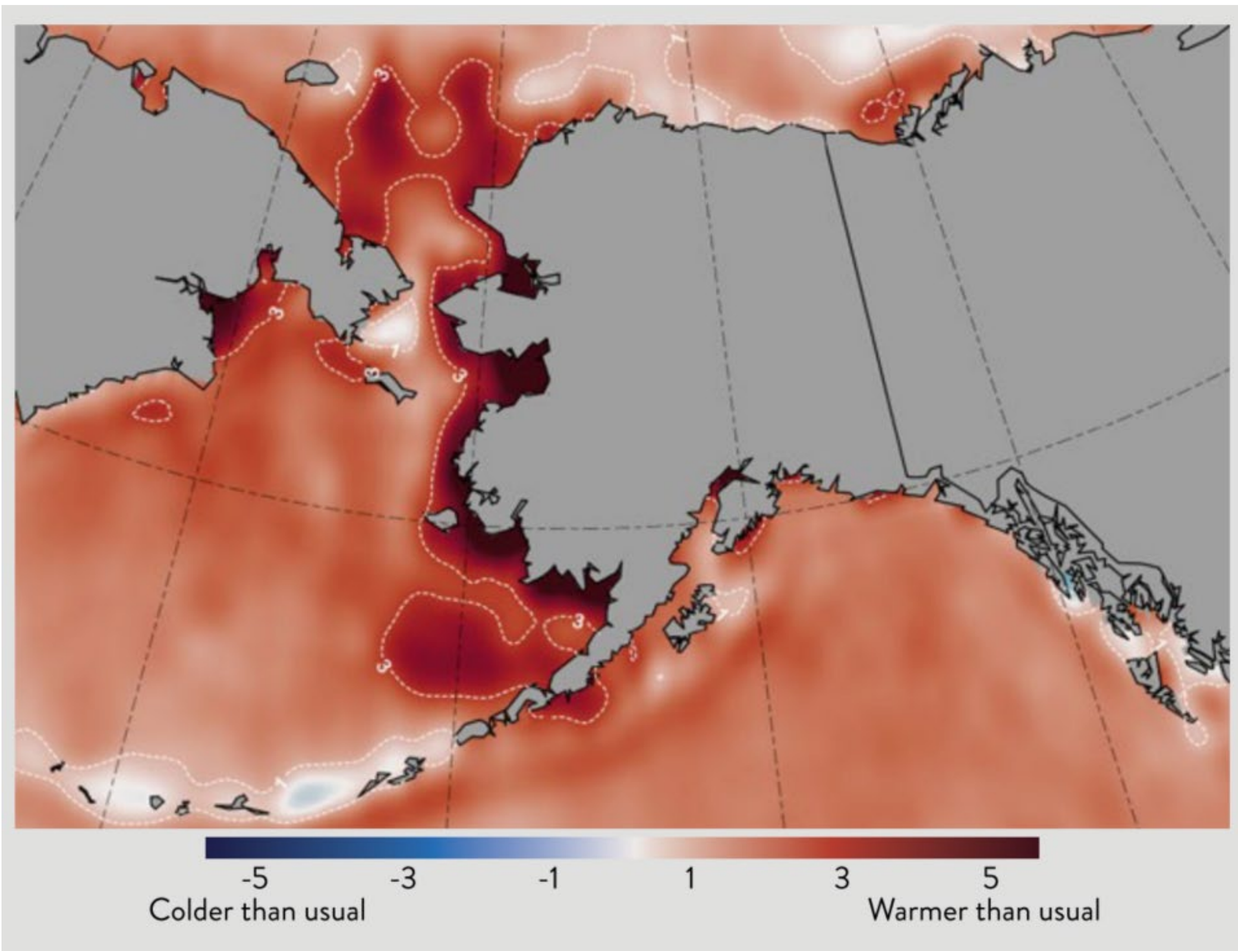

Figure 6. Shades of red indicate summer sea surface temperatures that were warmer than average during 2014-2018, especially along the west coast.

Another ocean water anomaly is described as a marine heat wave. Marine heat waves are described as a coherent area of extreme warm temperature at the sea surface that persists (Frölicher et al. 2018). Marine heatwaves are a key ecosystem driver and there has been an increase from 30 percent in 2012 to nearly 70 percent of global oceans in 2016 experiencing strong or severe heatwaves (Suryan et al. 2021). The largest recorded marine heat wave occurred in the northeast Pacific Ocean from 2013-2015 (Frölicher et al. 2018). Initially called "the blob" the northeast Pacific marine heatwave (PMH) first appeared off the coast of Alaska in the winter of 2013-2014 and by the end of 2015 it stretched from Alaska to Baja California. In mid-2016, the PMH began to dissipate, based on sea surface temperature data 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 (capelin and herring), Steller sea lions, adult cod, chinook and sockeye salmon in the Gulf of Alaska were all impacted by the PMH (Bond et al. 2015; Peterson et al. 2016; Sweeney et al. 2018).

The 2018 Pacific cod stock assessment[6] 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 PMH. In 2020 the spawning stock biomass dropped below 20 percent of the unfished spawning biomass and the federal Pacific cod fishery in the Gulf of Alaska was closed by regulation to directed Pacific cod fishing (Barbeaux et al. 2020). Twenty percent is a minimum spawning stock size threshold instituted to help ensure adequate forage for the endangered western stock of Steller sea lions.

Ocean Acidification

For 650,000 years or more, the average global atmospheric carbon dioxide (CO_2) concentration varied between 180 and 300 parts per million (ppm), but since the beginning of the industrial revolution in the late 1700s, atmospheric CO_2 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 CO_2 released, which has buffered the increase in atmospheric CO_2 concentrations (Feely et al. 2009; Feely et al. 2004). Despite the oceans' role as large carbon sinks, the CO_2 level continues to rise and is currently at 419 ppm[7].

As the oceans absorb CO_2, the buffering capacity, and ultimately the 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 et al. 2009; Reisdorph and Mathis 2014). When seawater is supersaturated with these minerals, calcification (growth) of shells is favored. Likewise, when the sea water becomes undersaturated, dissolution is favored (Feely et al. 2009).

[6]NOAA Fisheries, Alaska Fisheries Science Center website. Available at https://apps-afsc.fisheries.noaa.gov/REFM/stocks/Historic_Assess.htm, accessed December 2, 2020.
[7] NOAA Global Monitoring Laboratory website. Trends in Atmospheric Carbon Dioxide. Available at https://www.esrl.noaa.gov/gmd/ccgg/trends/, accessed May 31, 2021.

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 indicated 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 respect to aragonite (Feely et al. 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 CO_2 and exacerbate the problem of aragonite undersaturation in the Arctic (DeGrandpre et al. 2020; Yamamoto et al. 2012).

Undersaturated waters are potentially highly corrosive to any calcifying organism, such as corals, bivalves, crustaceans, echinoderms and many forms of zooplankton such as copepods and pteropods, and consequently may affect Arctic food webs (Bates et al. 2009; Fabry et al. 2008). 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). Because of their thin shells and dependence on aragonite, under increasingly acidic conditions, pteropods may not be able to grow and maintain shells (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 (Burek et al. 2008; Doney et al. 2012; Hinzman et al. 2005; 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, changes in periodic life cycles of species. For example, cetaceans with restricted distributions linked to water temperature may be particularly susceptible to range restriction (Isaac 2009; Learmonth et al. 2006). 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). These characteristics describe the habitat used by Cook Inlet beluga whales.

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.

This section consists of narratives for each of the ESA-listed species that are likely to be adversely affected by the proposed action. In each narrative, we present a summary of information on the population structure and distribution of each species to provide a foundation for the exposure analyses that appear later in this opinion. Then we summarize information on the threats to the species and the species' status given those threats to provide points of reference for the jeopardy determinations we make later in this opinion. That is, we rely on a species' status and trend to determine whether or not an action's effects are likely to increase the species' probability of becoming extinct. For designated critical habitat, we present a summary of the critical habitat designation, the geographical area of the designation, and any physical or biological features essential to the conservation of the species, as well as any relevant threats and management considerations. That is, we rely on the status of critical habitat and its function as a whole to determine whether an action's effects are likely to diminish the value of critical habitat as a whole for the conservation of listed species.

4.3.1. Cook Inlet DPS Beluga Whale

4.3.1.1 Population Structure and Status

Beluga whales inhabiting Cook Inlet are one of five distinct stocks found in Alaska (Muto et al. 2020). The best historical abundance estimate of the Cook Inlet beluga population was from a survey in 1979, which estimated a total population of 1,293 belugas (Calkins 1989). NMFS began conducting comprehensive, systematic aerial surveys of the Cook Inlet beluga population in 1993. These surveys documented a decline in abundance from 653 belugas in 1994 to 347 belugas in 1998. In response to this nearly 50 percent decline, NMFS designated the Cook Inlet beluga population as depleted under the Marine Mammal Protection Act in 2000 (65 FR 34590; May 31, 2000). The lack of population growth since that time led NMFS to list the Cook Inlet beluga as endangered under the ESA on October 22, 2008 (73 FR 62919).

The best estimate of 2018 abundance for the Cook Inlet beluga whale population from the aerial survey data is 279 whales (95 percent probability interval of 250 to 317; Shelden and Wade 2019). A comparison of the population estimates over time is presented in Figure 7. Over the most recent 10-year time period (2008-2018), the estimated trend in abundance is approximately -2.3 (-4.1-0.6) percent/year (Figure 7) (Shelden and Wade 2019). This is a steeper decline than the previously estimated decline of -0.5 percent/year (Shelden et al. 2017). The methods presented in Shelden and Wade (2019) were developed by incorporating additional data and an improved methodology for analyzing the results of aerial population surveys. NMFS used a new group size estimation method (Boyd et al. 2019) and new criteria to determine whether certain data from aerial surveys could be used reliably. Shelden and Wade (2019) report abundance estimates dating back to 2004 that have been adjusted using the new methodology.

Based on an analysis of stranding deaths from 2005 to 2017 (95 individuals), McGuire et al. (2020a) suggest a minimum mean annual mortality estimate of 2.2 percent (SE = 0.36 percent) calculated from the ratio of reported dead Cook Inlet beluga whales to aerial survey-based estimates of population size. This is a minimum estimate because reported dead Cook Inlet beluga whales are a subset of the total number that died because of the challenges in discovering stranded animals in Cook Inlet. Cook Inlet has over 2,400 km of shoreline (Zimmermann and Prescott 2014) and a tiny fraction of that coastline is bordered by roads, the railroad, recreational areas with coastal access for hiking, biking, or off-road vehicles or is regularly traversed by established flight paths or vessel routes where someone could spot a stranded animal. In addition, nearly all dead belugas are found between April and October (only 4 from November through March) when visibility and access are better. It is reasonable to assume that some belugas die in the winter months and are never seen. Consequently, it is very likely that more belugas die than are found dead. McGuire et al. (2020a) suggest the mean number of reported Cook Inlet beluga whale carcasses represents less than one third of the total number of dead belugas each year.

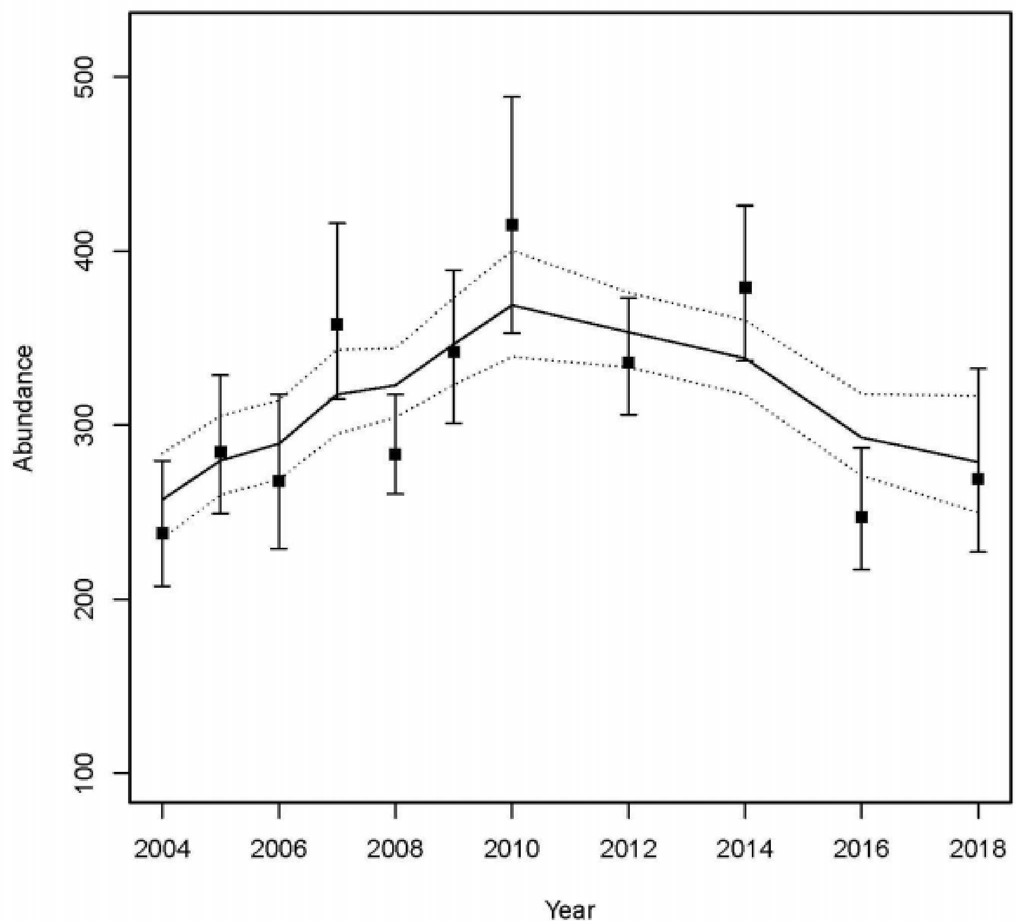

Figure 7. Cook Inlet beluga whale annual abundance estimates (squares), the moving average (solid line), and 95 percent probability intervals (dotted lines) (Shelden and Wade 2019).

Reported mortality was greatest for adults of reproductive age, followed by calves, with fewer subadults and no adults older than 49 years in the stranding data set. McGuire et al. (2020a) note that this is an unusual result and that if the Cook Inlet beluga whale population was similar to other healthy mammal populations, higher mortality of the very old and the very young compared to other age groups would be expected. The results from McGuire et al. (2020a) are consistent with Vos et al. (2019), suggesting that adult 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 seventy plus years as reported in other beluga populations.

The Cook Inlet Beluga Recovery Plan (NMFS 2016b) examined potential obstacles to the recovery of Cook Inlet belugas. Climate change, while considered a potential threat to beluga recovery, is not addressed as a separate threat in the recovery plan, but rather is discussed with respect to how it may affect each of the listed threats.

The Recovery Plan discusses the fact that there are inherent risks associated with small populations, such as loss of genetic or behavioral diversity. Small populations are more susceptible to disease, inbreeding, predator pits, or catastrophic events than large populations. The Recovery Plan addresses ten principal threats to the Cook Inlet beluga population and considers how they may be exacerbated by the inherent risks due to small population size.

A detailed description of the Cook Inlet beluga whales' biology, habitat, and extinction risk factors may 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 are geographically and genetically isolated from other beluga whale stocks in Alaska (Muto et al. 2020). Their distribution (Figure 8) overlaps with the entire action area. Although they remain year-round in Cook Inlet, they demonstrate seasonal movements within the inlet. In general, during the summer and fall, beluga whales occur in shallow coastal waters and are concentrated near the Susitna River mouth, Knik Arm, Turnagain Arm, and Chickaloon Bay (Castellote et al. 2016a; Shelden et al. 2015b). During the winter, ice formation in the upper Inlet may restrict beluga's access to nearshore habitat (Ezer et al. 2013), and they are more dispersed in deeper waters in the mid-inlet to Kalgin Island, and in the shallow waters along the west shore of Cook Inlet to Kamishak Bay.

Information on Cook Inlet beluga distribution, including aerial surveys and acoustic monitoring, indicates that the species' range in Cook Inlet has contracted markedly since the 1990s (Figure 8) (Shelden et al. 2015b). This distributional shift and range contraction coincided with the decline in abundance (Goetz et al. 2012; Moore et al. 2000; NMFS 2008a). Beginning in 1993, aerial surveys have been conducted annually or biennially in June and August by NMFS Marine Mammal Laboratory (Hobbs et al. 2012; NMFS 2008a). Historic aerial surveys for beluga whales also were completed in the late 1970s and early 1980s (Harrison and Hall 1978; Murray and Fay 1979). Results indicate that prior to the 1990s belugas used areas throughout the upper, mid, and lower Inlet during the spring, summer, and fall (Huntington 2000; NMFS 2008a; Rugh et al. 2000; Rugh et al. 2010). While the surveys in the 1970s showed whales dispersing into the lower inlet by mid-summer, almost the entire population is now 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-fall months. Groups of 200 to 300 individuals – almost the entire population – including adults, juveniles, and neonates, have been observed in recent years in the Susitna River Delta area (McGuire et al. 2014). NMFS refers to this preferred summer-fall habitat near the Susitna Delta as the Susitna Delta Exclusion Zone and seeks to minimize human activity in this area of extreme importance to Cook Inlet beluga whale survival and recovery.

While belugas are concentrated primarily in the upper inlet during the summer and fall months, the area around the East Forelands between Nikiski, Kenai, and Kalgin Island appears to provide important habitat in winter, early spring, and fall. Belugas were historically seen in and around the Kenai and Kasilof Rivers during June aerial surveys conducted by ADFG in the late 1970s and early 1980s and by NMFS starting in 1993 (Shelden et al. 2015b), and throughout the summer by other researchers and local observers. In recent years sightings near these rivers have been more typical in the spring and fall (Ovitz 2019). Details of additional records and sightings in the Kasilof River and Tuxedni Bay are presented in the biological opinion for the PCT (NMFS 2020).

The Alaska Beluga Monitoring Partnership (AKBMP)[8], a citizen science project, recorded 386 sightings in the Kenai River (48 groups, with an average group size of 9 belugas) during 73 monitoring sessions between August and October 2019. While visual sightings indicate peaks in spring and fall, acoustic detections indicate that belugas may be present in the Kenai River throughout the winter (Castellote et al. 2016a; NMFS unpublished data). Combined, both the acoustic detections and visual sightings indicate that there appears to be a steep decline in beluga presence in the Kenai River area during the summer (June through August), despite the historic sightings of belugas throughout the summer in the area and an annual return of 1 – 1.8 million[9] sockeye salmon in recent years, which are important beluga prey.

From December 2015 through January 2016, Tyonek Platform (located in upper Cook Inlet) personnel observed 200 to 300 Cook Inlet beluga whales, including calves, regularly. They appeared to be drifting by the platform on the afternoon tides, in the open water areas between ice sheets. One operator, working in Cook Inlet for 30 years, stated that he had never seen them in the winter before the 2015 to 2016 season (S. Callaway, pers. comm. 01/19/2016). Hilcorp reported 143 sightings of beluga whales from May through August while conducting pipeline work in upper Cook Inlet (Sitkiewicz et al. 2018).

---

[8] https://akbmp.org/

[9] https://www.adfg.alaska.gov/sf/FishCounts/index.cfm?ADFG=main.displayResults&COUNTLOCATIONID=40&SpeciesID=420

During geotechnical activities along Seward Highway, beluga whales were observed on 15 of the 16 days of monitoring at Twentymile Bridge from April 6 to April 23, 2015. There were 18 observations of beluga whale groups, ranging in size from 3-30 (HDR 2015). Frequent sightings of belugas at the mouth of the Twentymile River are consistent with 2018 observations reported by the Beluga Whale Alliance where, from August 10-Oct. 9, belugas were observed at the Twentymile River mouth on 12 of 22 occasions (Beluga Whale Alliance, unpublished data).

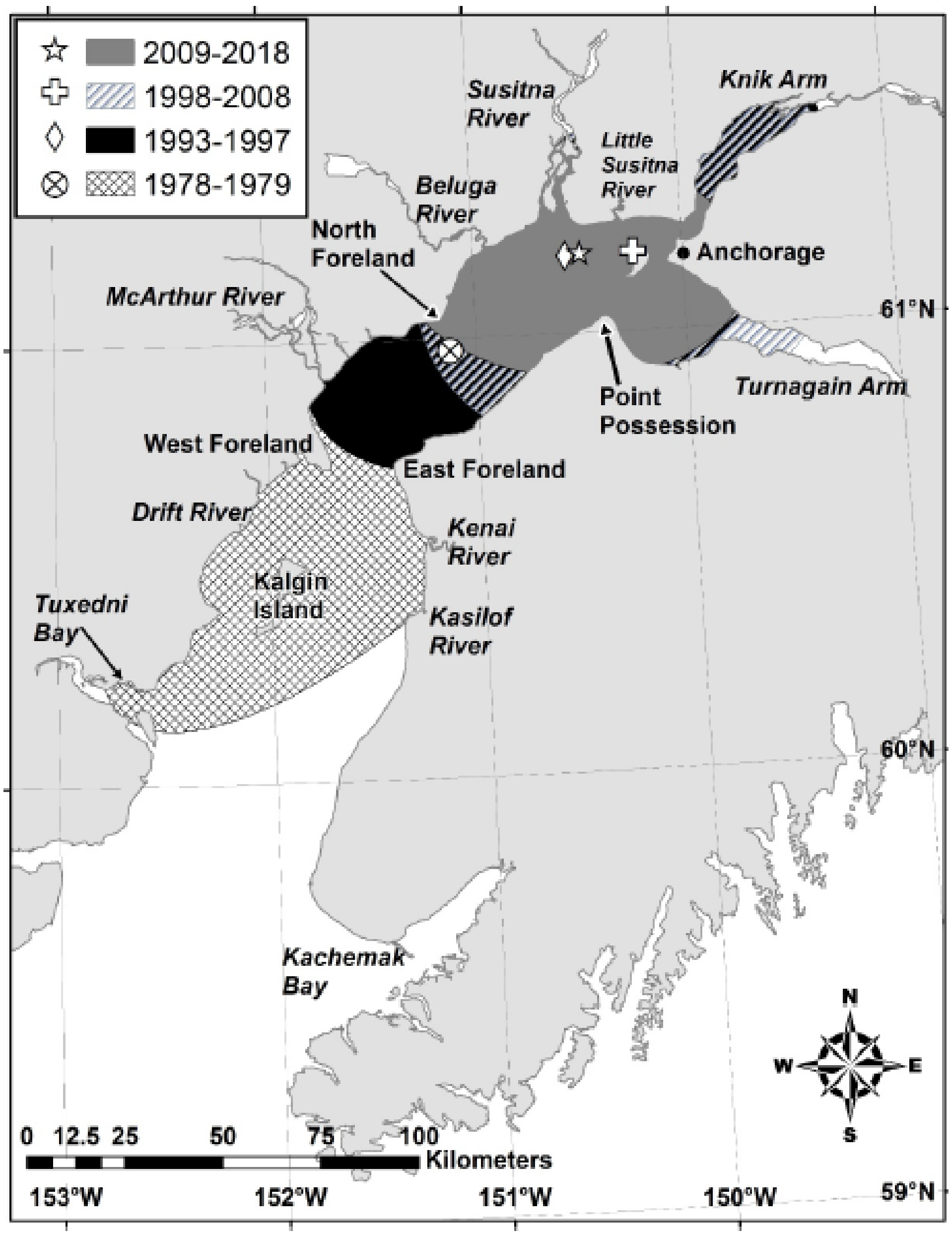

Figure 8. Summer range contraction over time as indicated by ADFG and NMFS aerial surveys. Adapted from Shelden and Wade (2019). The 95 percent core summer distribution contracted from 7,226 sq. km in 1978–79 to 2,110 sq. km in 2009–18 (29 percent of the 1978–79 range).

4.3.1.3 Presence in Knik Arm/Port of Alaska

Multiple groups have conducted beluga studies in Knik Arm over the past 15 to 20 years both at and near the POA, including NMFS, LGL Alaska Research Associates Inc., the Cook Inlet Photo-ID Project, Alaska Pacific University, the POA (during various port construction and maintenance projects), and Joint Base Elmendorf-Richardson. The biological opinion for the Port of Alaska's Petroleum and Cement Terminal (PCT) (NMFS 2020) provides a detailed review of the monitoring and sightings that have been recorded for beluga whales in the vicinity of the port; here we provide a more general overview that focuses on the time frame of the proposed project.

Beluga whales can be found in Knik Arm year-round, but are more frequently observed in the summer and fall (Figure 9). McGuire and Stephens (2017) reported that during boat- and land-based photo-identification (ID) surveys, large concentrations of belugas were present in Knik Arm from mid-August through mid-September. During this period, their movements in the area were typically characterized by traveling to upper Knik Arm with the high tide and following the low tide back down to Eagle Bay and the Port. Beluga whales observed in Knik Arm during the autumn were most frequently observed on the western side of the arm (Funk et al. 2005). McGuire and Stephens (2017) noted that belugas will travel between Knik Arm and Turnagain Arm using both the channel between Fire Island and Anchorage and the longer route along the western shore passing the Susitna Delta.

Belugas are more likely to be present in Eagle Bay during low tides (Funk et al. 2005; Joint Base Elmendorf-Richardson 2010; McGuire et al. 2008; McGuire et al. 2018). During scientific and construction monitoring at the Port, Cornick et al. (2011) reported that belugas were present at all tidal stages near the Port (lower Knik Arm), however there were more belugas present during low slack tide than any other tide stage.

The AKBMP citizen science project recorded 75 sightings (23 groups) at the Ship Creek small boat launch (with group sizes ranging from 1-12 belugas, average size 3) from August 15 through October 31, 2019 (68 days with monitoring sessions).

Dredging occurred at the POA from May – September 2019. No belugas were observed during either May or July. During June, belugas were seen only between 21-29 June, with the groups ranging in size from 2 to 18 belugas and an average of about 7 whales (POA 2019). When dredging re-commenced in August, belugas were observed on nearly every day, with group sizes most often 3-15 whales, however some groups were as large as 85 animals. Dredging continued until September 17, however the last sighting of belugas during dredging was on September 10.

The USACE also conducted dredging at the POA between April and October 2018. During their operations, 24 belugas were observed in June, 12 in July, 75 in August, and 5 each in September and October (USACE 2019).

In April 2016, marine mammal monitoring occurred at Port MacKenzie during pile driving operations for emergency repair of the seawall. Observers recorded belugas in or near the pile driving exclusion zone on 12 occasions on 7 days from April 18-26. No pile driving was occurring during any of these close approaches, so no takes occurred and no shut-downs were ordered (LLC 2016).

The POA conducted dedicated monitoring during PCT Phase 1 construction between April and November 2020 (61 North Environmental 2021a). In total, protected species observers (PSOs) observed 245 groups and approximately 987 individual Cook Inlet beluga whales near the POA (group sizes ranged from 1 to 53 individuals), with the most number of individuals and groups being seen in August (N = 56 groups and 274 individuals) and September (N = 73 groups and 276 individuals). The highest single-day count of belugas occurred on 10 September 2020, when 131 belugas were sighted. Cook Inlet beluga whales were observed in every month of the project except during October, which had only three monitoring days. The highest sightings per unit effort, measured as Cook Inlet beluga whales per hour of observation, occurred at the end of August and beginning of September with 1.81 and 3.22 belugas sighted per hour, respectively.

Monitoring for PCT Phase 2 began on April 26, 2021. For this portion of the project 35 Level B harassment takes of Cook Inlet beluga whales are authorized. Installation of the first 144” monopile did not occur until May 26. For the period of April 26- May 30, 2021, 78 Cook Inlet beluga whales were sighted in 23 groups. Seven potential Level B takes of Cook Inlet beluga whales occurred during installation of the 144” piles in this timeframe. From May 31 to June 27, 2021, an additional 3 potential Level B takes occurred for a cumulative total of 10 through the end of June (61 North Environmental 2021b).

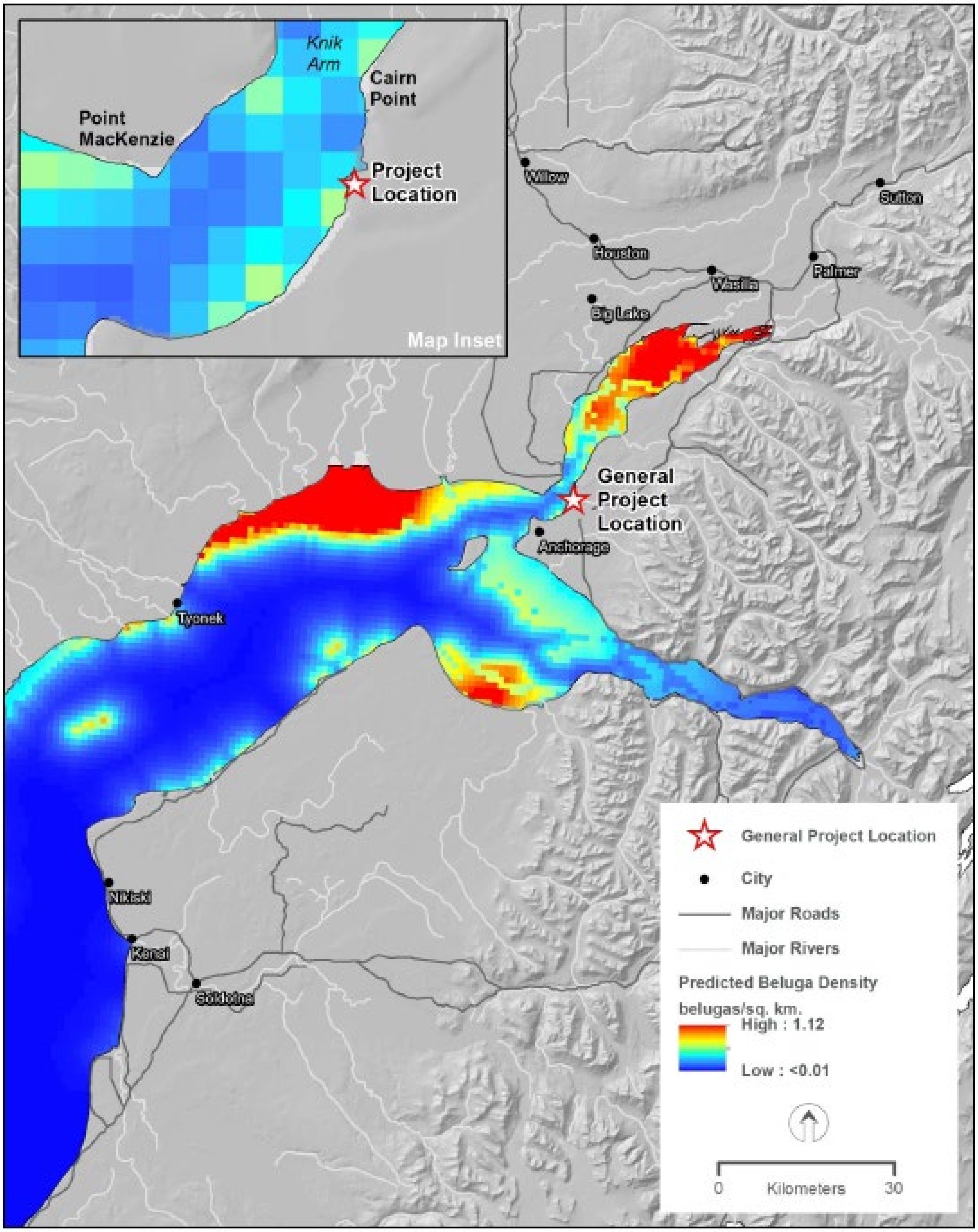

Figure 9. Predicted beluga whale densities within Upper Cook Inlet during summer (Goetz et al. 2012).

4.3.1.4 Behavior and Group Size

Beluga whales are extremely social and often interact in close, dense groups. McGuire and Stephens (2017) observed increasing maximum group size of Cook Inlet beluga whales since

2012, and as mentioned above, groups of 200 or more individuals (maximum group size of 313 whales – almost the entire population) were seen in the Susitna River Delta area. Mean group sizes during the summer and fall were largest in July (57) and smallest in October (13.9), with the largest groups seen during mid-July and early August in the Susitna River Delta, while the smallest group sizes were in the Kenai River Delta.

Most calving in Cook Inlet is assumed to occur from mid-May to mid-July (Calkins 1989); NMFS unpublished data). 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).

Neonates have been photographed in Cook Inlet as early as mid-July and as late as October, during a field season that generally runs May through October. The only documented observation of a beluga whale birth occurred on July 20, 2015 in the Susitna River Delta, which corroborates the importance of the Susitna River Delta as a Cook Inlet beluga whale calving ground (McGuire and Stephens 2017; Shelden et al. 2019). Shelden et al. (2019) predicted birth dates of stranded neonates, fetuses, and calves of the year and suggested that calving could occur through the entire ice-free period from April through November. The predicted peak range of conception dates for the stranded animals was March through May, however, conception dates have been exhibited over a seven-month period, including two fetuses with predicted conception dates in December and January. Probable mating behavior of belugas was observed in April and May of 2014, in Trading Bay (Lomac-MacNair et al. 2016).

4.3.1.5 Feeding and Prey Selection

Cook Inlet beluga whales have diverse diets (Nelson et al. 2018; Quakenbush et al. 2015), foraging on fish and benthos, often 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). In early spring, belugas travel up to Twenty Mile River and Placer Creek in Turnagain Arm, following runs of eulachon.

The seasonal availability of energy-rich prey such as eulachon and salmon is very important to the energetics of belugas (Abookire and Piatt 2005; Litzow et al. 2006). Eating fatty prey and building up fat reserves throughout spring and summer may allow beluga whales to sustain themselves during periods of reduced prey availability in winter or through times of stress when metabolic needs are higher (NMFS 2007). Saupe et al. (2014) found that the biomass and individual sizes of benthic fauna available to beluga whales were low in Cook Inlet in the winter. They concluded based on the small body sizes and apparent low density of benthic fauna that belugas may not be acquiring a maintenance ration during winter, consistent with previous observations that belugas in the spring have much lower fat reserves than after feeding on abundant eulachon and salmon in the spring and summer (NMFS 2007; Saupe et al. 2014).

4.3.1.6 Hearing, Vocalizations, and Other Sensory Capabilities

Like other odontocete, or toothed, cetaceans, beluga whales produce sounds for two overlapping functions: communication and echolocation. For their social interactions, belugas emit communication calls with an average frequency range of about 0.2 to 7.0 kHz (well within the human hearing range) (Garland et al. 2015), and the variety of audible whistles, squeals, clucks, mews, chirps, trills, and bell-like tones they produce have led to their nickname of “canaries of the sea” (Castellote et al. 2014). Belugas and other odontocetes make sounds across some of the widest frequency bands that have been measured in any animal group.

At the higher frequency end of their hearing range, belugas use echolocation signals (biosonar) with peak frequencies at 40-120 kHz (Au 2000) to navigate and hunt in dark or turbid waters, where vision is limited. 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; Stoeger et al. 2012; Tyack 1999).

Even among odontocetes, beluga whales are known to be among the most adept users of sound. It is possible that the beluga whale’s unfused vertebrae, and thus the highly movable head, have allowed adaptations for their sophisticated directional hearing. Multiple studies have examined hearing sensitivity of belugas in captivity (Awbrey et al. 1988; Finneran et al. 2005; Finneran et al. 2002a; Finneran et al. 2002b; Johnson et al. 1989; Klishin et al. 2000; Mooney et al. 2008; Ridgway et al. 2001), however, the results are difficult to compare across studies due to varying research designs, complicating factors such as ototoxic antibiotics (e.g., Finneran et al. 2005), and small sample sizes. In the first report of hearing ranges of belugas in the wild, Castellote et al. (2014) reported a wide range of sensitive hearing from 20-110 kHz, with minimum detection levels around 50 dB. In general, these results were similar to the ranges reported in the captive studies, however, the levels and frequency range indicate that the belugas in the Castellote et al. (2014) study have sensitive hearing when compared to previous beluga studies and other odontocetes (Houser and Finneran 2006; Houser et al. 2018).

Most of these studies measured beluga hearing in very quiet conditions. However, in Cook Inlet, tidal currents regularly produce ambient sound levels well above 100 dB (Lammers et al. 2013). Belugas’ signal intensity can change with location and background noise levels (Au et al. 1985).

4.3.1.7 Cook Inlet Beluga Whale Critical Habitat

NMFS designated critical habitat for the Cook Inlet beluga whales on April 11, 2011 (Figure 10; 76 FR 20180). Critical habitat includes two areas: Area 1 and Area 2 that together encompass 7,800 km^2 (3,013 mi^2) of marine and estuarine habitat in Cook Inlet (76 FR 20180). For national security reasons, critical habitat excludes all property and waters of Joint Base Elmendorf-Richardson (JBER) and waters adjacent to the Port of Alaska. Portions of critical habitat Area 1 and Area 2 exist within the action area (Figure 11).

Critical habitat Area 1 consists of 1,909 km^2 (738 mi^2) of Cook Inlet, north of Threemile Creek and Point Possession (76 FR 20180). Area 1 contains shallow tidal flats or mudflats and mouths of rivers that provide important areas for foraging, calving, molting, and escape from predation. High concentrations of beluga whales are often observed in these areas from spring through fall. Additionally, anthropogenic threats have the greatest potential to adversely impact beluga whales in critical habitat Area 1 (76 FR 20180).

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

The Cook Inlet Beluga Whale Critical Habitat Final Rule (76 FR 20180) included designation of five Primary Constituent Elements (PCEs, referred to in this opinion as Physical and Biological Features (PBFs). These five PBFs were deemed essential to the conservation of the Cook Inlet beluga whale (50 CFR § 226.220(c)). The PBFs are:

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

Although belugas may have abandoned critical habitat off of the Kenai River during the peak periods of large salmon runs, they make heavy use of salmon runs elsewhere in Upper Cook Inlet, most notably using waters near the mouth of the Susitna and Beluga rivers, and rivers feeding into Knik Arm and Chickaloon Bay (Goetz et al. 2012). In addition, they continue to use the waters in the lower 9 miles of the Kenai River during periods of low in-river human activity (Ovitz 2019). Overall, salmon returns in Cook Inlet drainages remain strong, however Brenner et al. (2019) reported that the 2018 Upper Cook Inlet commercial harvest of salmon was 61 percent less than the recent 10-year average annual harvest.

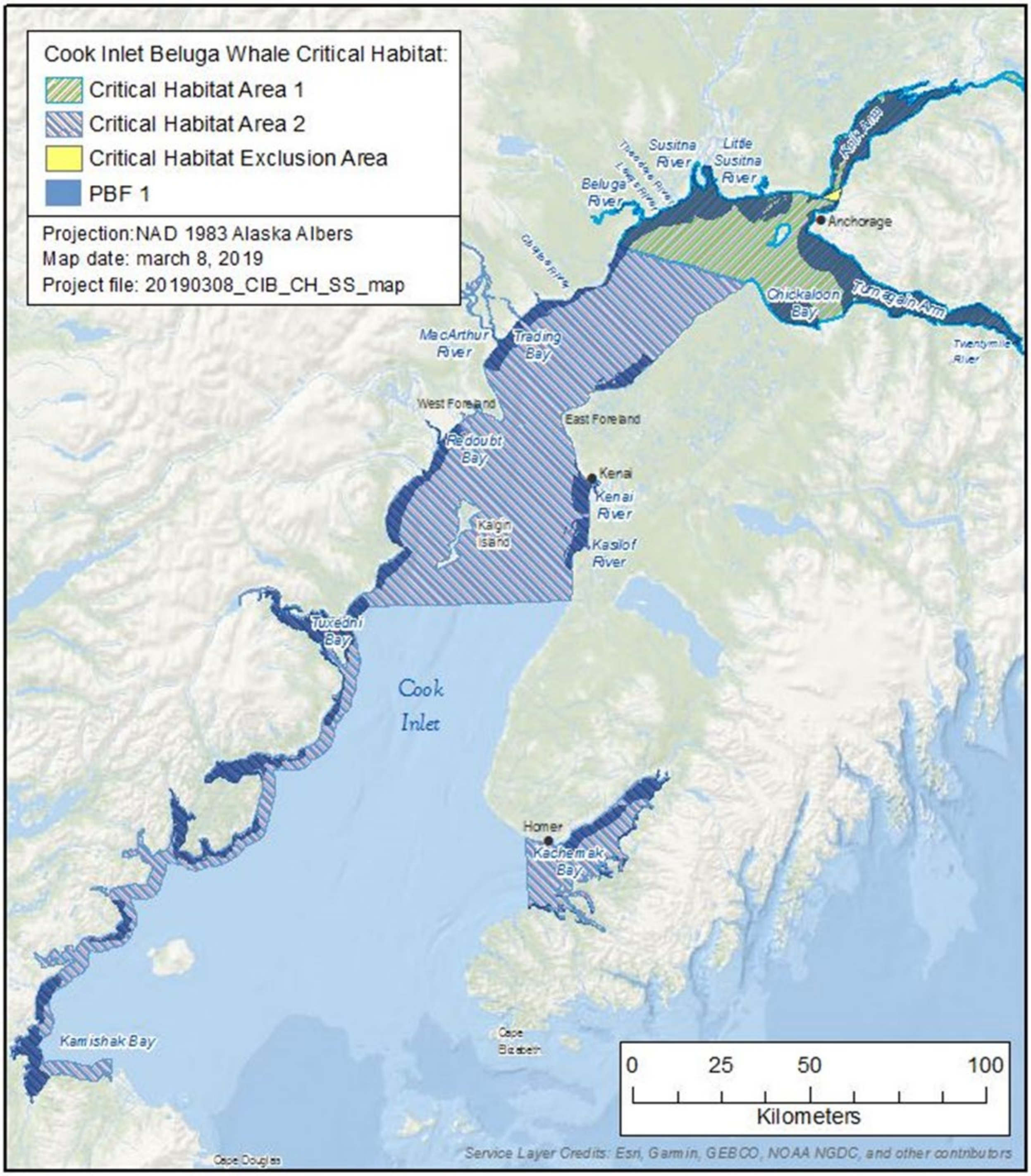

Figure 10. Designated critical habitat for Cook Inlet beluga whales.

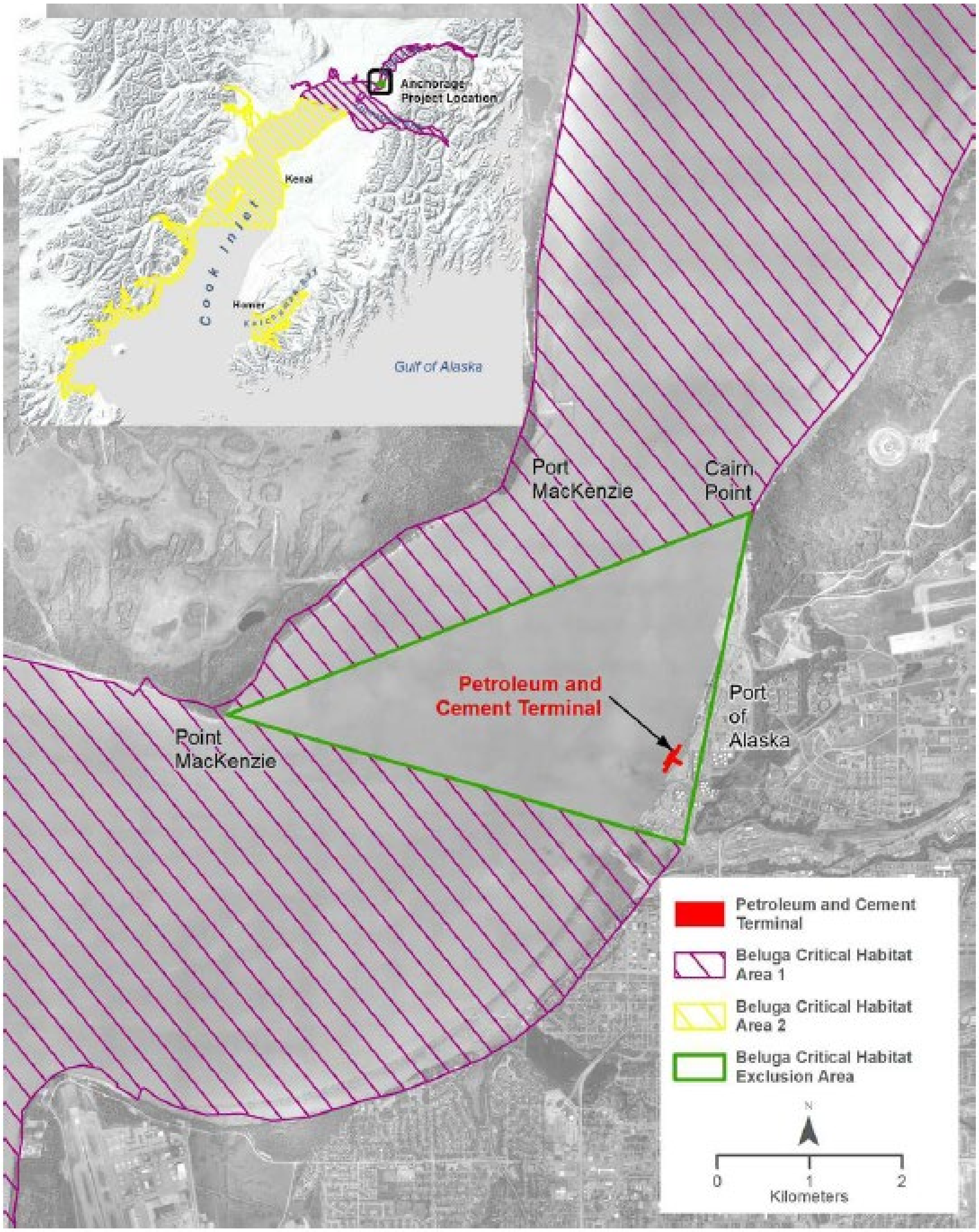

Figure 11. Designated Cook Inlet beluga critical habitat near the POA SFD site.

4.3.2. Steller sea lion

4.3.2.1 Status and Population Structure

The Steller sea lion was listed as a threatened species under the ESA on November 26, 1990 (55 FR 49204). In 1997, NMFS reclassified Steller sea lions as two DPSs based on genetic studies and other information (62 FR 24345; May 5, 1997). At that time, the eastern DPS (which includes animals from east of Cape Suckling, Alaska, at 144°W longitude) was listed as threatened and the Western DPS (which includes animals from west of Cape Suckling, at 144°W longitude) was listed as endangered. On November 4, 2013, the eastern DPS was removed from the endangered species list (78 FR 66140). Information on Steller sea lion biology, threats, and habitat (including critical habitat) is available in the revised Steller Sea Lion Recovery Plan (NMFS 2008b).

As summarized most recently by Muto et al. (2020), the Western DPS of Steller sea lions decreased from an estimated 220,000 to 265,000 animals in the late 1970s to less than 50,000 in 2000. Factors that may have contributed to this decline include incidental take in fisheries, competition with fisheries for sea lion prey, legal and illegal shooting, predation, exposure to contaminants, disease, and ocean regime shift climate change (NMFS 2008b). The most recent comprehensive aerial photographic and land-based surveys of Western DPS Steller sea lions in Alaska (Fritz et al. 2016; Sweeney et al. 2018) estimated a total Alaska population (both pups and non-pups) of 52,932 (Muto et al. 2020). There are strong regional differences in trends in abundance of Western DPS Steller sea lions, with mostly positive trends in the Gulf of Alaska and eastern Bering Sea east of Samalga Pass (~170°W longitude) and generally negative trends to the west in the Aleutian Islands.

The population trends in the Gulf of Alaska were observed to be increasing until 2015 (Sweeney et al. 2018); however, in 2017, NMFS surveys observed anomalously low pup counts in these areas (Sweeney et al. 2018), which may be related to low availability of prey associated with warm ocean temperatures in the Gulf of Alaska during 2014-2016. The 2020 Pacific cod stock assessment indicated a continued low biomass level, and NMFS closed the Gulf of Alaska Pacific cod directed fishery for the 2020 season (50 CFR 679.20(d)(4)).

4.3.2.2 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 12) (Loughlin et al. 1984). Although Steller sea lions seasonally inhabit coastal waters of Japan in the winter, breeding rookeries outside of the U.S. are located only in Russia (Burkanov and Loughlin 2005). Steller sea lions are not known to migrate annually, but individuals may widely disperse outside of the breeding season (late-May to early-July) (Jemison et al. 2013; Muto et al. 2020).

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

Most adult Steller sea lions occupy rookeries during the pupping and breeding season, which extends from late May to early July (Gisiner 1985; Pitcher and Calkins 1981), 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 (Ban 2005; Call and Loughlin 2005; Rice 1998).

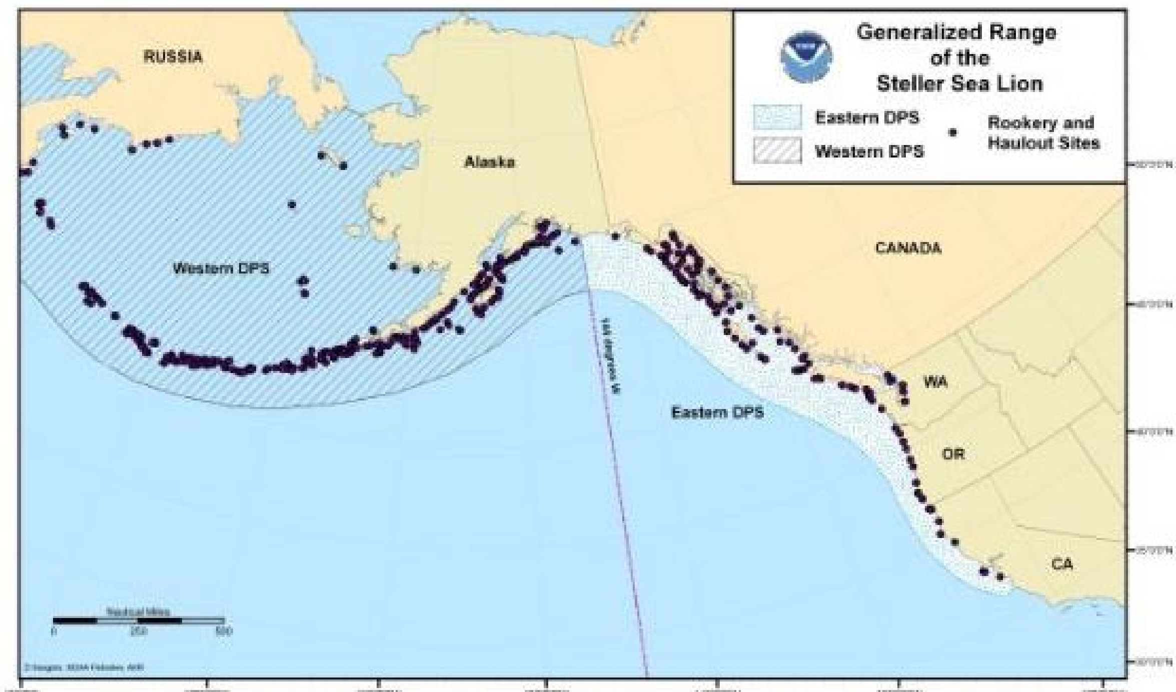

Figure 12. Generalized ranges of Western DPS and Eastern DPS Steller sea lions.

About 3,600 sea lions use terrestrial sites in the lower Cook Inlet area (Sweeney et al. 2017), with additional individuals venturing into the area to forage. However, the nearest terrestrial sites (including rookeries and haulouts) to the POA are over 200 km away in the lower inlet (Figure 13).

4.3.2.3 Presence in Cook Inlet

Steller sea lions are not commonly seen in the mid and upper Inlet. Sightings during NMFS aerial survey for belugas in Cook Inlet indicate that the majority of all Steller sea lions are expected to be found south of the Forelands (Rugh et al. 2005; Shelden et al. 2015a). Sightings of Steller sea lions in the middle and upper areas of Cook Inlet are rare (Jacobs Engineering 2017a). Steller sea lions occupy rookeries during their pupping and breeding season (late May to early July), however, there have been sightings of small numbers of Steller sea lions during oil and gas projects in recent years. In 2012, during Apache's 3D Seismic surveys, there were three sightings of approximately four individuals in upper Cook Inlet (Lomac-MacNair et al. 2013). Marine mammal observers associated with Buccaneer's drilling project off Cape Starichkof observed seven Steller sea lions during the summer of 2013 (Owl Ridge 2014). During SAExploration's 3D Seismic Program in 2015, four Steller sea lions were observed in Cook Inlet. One sighting occurred between the West and East Forelands, one near Nikiski, and one northeast of the North Foreland in the center of Cook Inlet (Kendall et al. 2015). One Steller sea lion was observed near Ladd Landing for the Harvest Alaska Cook Inlet Pipeline Cross-Inlet Extension (CIPL) project during the summer (Sitkiewicz et al. 2018).

Density data is not available for Steller sea lions in upper Cook Inlet. Steller sea lions are expected to be encountered in low numbers, if at all, within the action area. Although Steller sea lions are rarely present in Knik Arm, they have been documented in Knik Arm during past POA projects. Monitoring data covers the construction season (April through November) across multiple years of effort. Three sightings of what was likely a single individual occurred in the project area in 2009 and two sightings occurred in 2016. During dredging activities at the POA in June 2019, a Steller sea lion was observed in the port area on one day (POA 2019). Steller sea lions can linger in the area for multiple days. Most recently, up to six Steller sea lions were observed across four days between May 29 and June 24, 2020, during Phase 1 PCT construction monitoring (61 North Environmental 2021a). At least two of these observations may have been re-sights on the same individual. An additional seven unidentified pinnipeds were observed that could have been Steller sea lions or harbor seals (61 North Environmental 2021a).

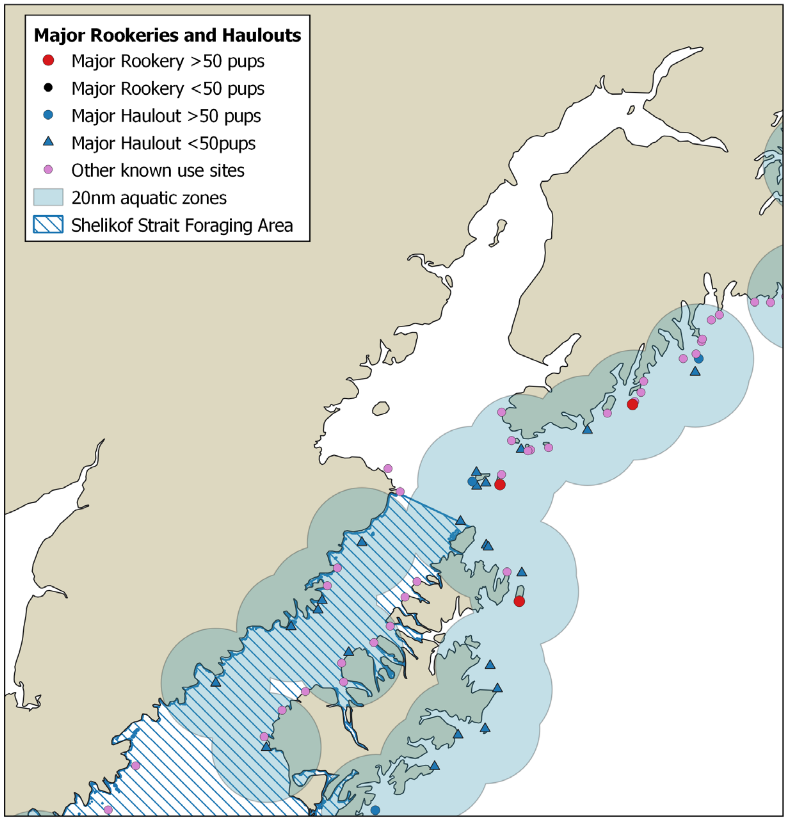

Figure 13. Steller sea lion sites in and near Cook Inlet. Designated critical habitat in this region includes the major rookeries, major haulouts, adjacent land and air zones within 3000 ft of the major rookeries and haulouts, 20nm aquatic zones around major rookeries and haulouts, and the Shelikof Strait aquatic foraging area (50 CFR § 226.202).

4.3.2.4 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 (Calkins and Goodwin 1988; NMFS 2008b; Pitcher and Calkins 1981) and occasionally other marine mammals and birds (NMFS 2008b; Pitcher and Fay 1982).

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

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

Because of their polygynous breeding behavior, in which individual, adult male sea lions will breed with a large number of adult females, Steller sea lions have clearly defined social interactions. Steller sea lions are gregarious animals that often travel in large groups of up to 45 individuals (Keple 2002), and rafts of several hundred Steller sea lions are often seen 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).

4.3.2.5 Hearing, Vocalizations, 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 2018a). 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. Western North Pacific DPS and Mexico DPS Humpback Whales

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

Additional information on humpback whale biology and natural history is available at:

https://www.fisheries.noaa.gov/species/humpback-whale

http://alaskafisheries.noaa.gov/pr/humpback

https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-species-stock

4.3.3.1 Status and Population Structure

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

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

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

Approximately 1,059 animals (CV=0.08) comprise the Western North Pacific DPS (Wade et al. 2016). The population trend for the Western North Pacific DPS is unknown. Humpback whales in the Western North Pacific remain rare in some parts of their former range, such as the coastal waters of Korea, and have shown little signs of recovery in those locations. The Mexico DPS is comprised of approximately 3,264 animals (CV=0.06) (Wade et al. 2016) with an unknown, but likely declining, population trend (81 FR 62260). The Hawaii DPS is comprised of 11,398 animals (CV=0.04). The annual growth rate of the Hawaii DPS is estimated to be between 5.5 and 6.0 percent.

Whales from these three DPSs overlap on feeding grounds off Alaska and are visually indistinguishable unless individuals have been photo-identified on breeding grounds and again on feeding grounds. All waters off the coast of Alaska may contain ESA-listed humpbacks.

Critical habitat was designated for the Western North Pacific and Mexico DPSs on April 21, 2021 (86 FR 21082). Only one essential feature of their critical habitat was identified, adequate prey resources. Although humpback whales are generalist predators and prey availability can vary seasonally and spatially, data indicate that their diet is consistently dominated by euphausiid species and small pelagic fishes such as northern anchovy, Pacific herring, Pacific sardine, and capelin (84 FR 54354). No critical habitat for the Western North Pacific DPS or the Mexico DPS occurs in Cook Inlet.

4.3.3.2 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 feed 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 mouth of Cook Inlet, and along the Aleutian Islands (Ferguson et al. 2015).

Humpback whales occur throughout the central and western Gulf of Alaska from Prince William Sound to the Shumagin Islands. Seasonal concentrations are found in coastal waters of Prince William Sound, Barren Islands, Kodiak Archipelago, Shumagin Islands, and south of the Alaska Peninsula. Large numbers of humpbacks have also been reported in waters over the continental shelf, extending up to 100 nm offshore in the western Gulf of Alaska (Wade et al. 2016).

4.3.3.3 Presence in Cook Inlet

Humpback whales have been observed throughout Cook Inlet, however, they are primarily seen in lower and mid Cook Inlet. During the NMFS aerial beluga whale surveys between 1993 and 2016, there were 88 sightings of an estimated 192 individual humpback whales (Figure 15), all of which occurred in the lower inlet (Rugh et al. 2000; Rugh et al. 2005; Shelden et al. 2015a; Shelden et al. 2017; Shelden et al. 2013). Additionally, during the 2013 marine mammal monitoring program, marine mammal observers reported 29 sightings of 48 humpback whales (Owl Ridge 2014) at Cosmopolitan State well site #A-1 (on the eastern part of lower Cook Inlet, about six miles north of Ninilchik), and during the 2014 Apache seismic surveys in Cook Inlet (south of the action area), marine mammal observers reported six individuals (Lomac-MacNair 2014).

Recent studies and monitoring events have also documented humpback whales further north in Cook Inlet, indicating that humpbacks occasionally use the upper Inlet. Marine mammal monitoring conducted north of the Forelands in May and June of 2015 reported two humpback whales (Jacobs Engineering 2017b). Shortly after these observations were made, a dead humpback was found in the same area, suggesting that this animal may have entered the area in a compromised state. PSOs observed two humpback whales near the mouth of Ship Creek, near Anchorage, in early September 2017 during dock renovation work (ABR 2017). In 2017, a dead humpback whale was seen floating in Knik Arm, finally beaching at Kincaid Park; necropsy results were inconclusive. Recent monitoring by Hilcorp in upper Cook Inlet during the CIPL project also included 3 humpback whale sightings near Ladd Landing, north of the Forelands (Sitkiewicz et al. 2018). In spring 2019, a young humpback whale stranded in Turnagain Arm. It was able to free itself on a high tide but a few days later a humpback whale was found dead in Cook Inlet and it was likely the same animal.

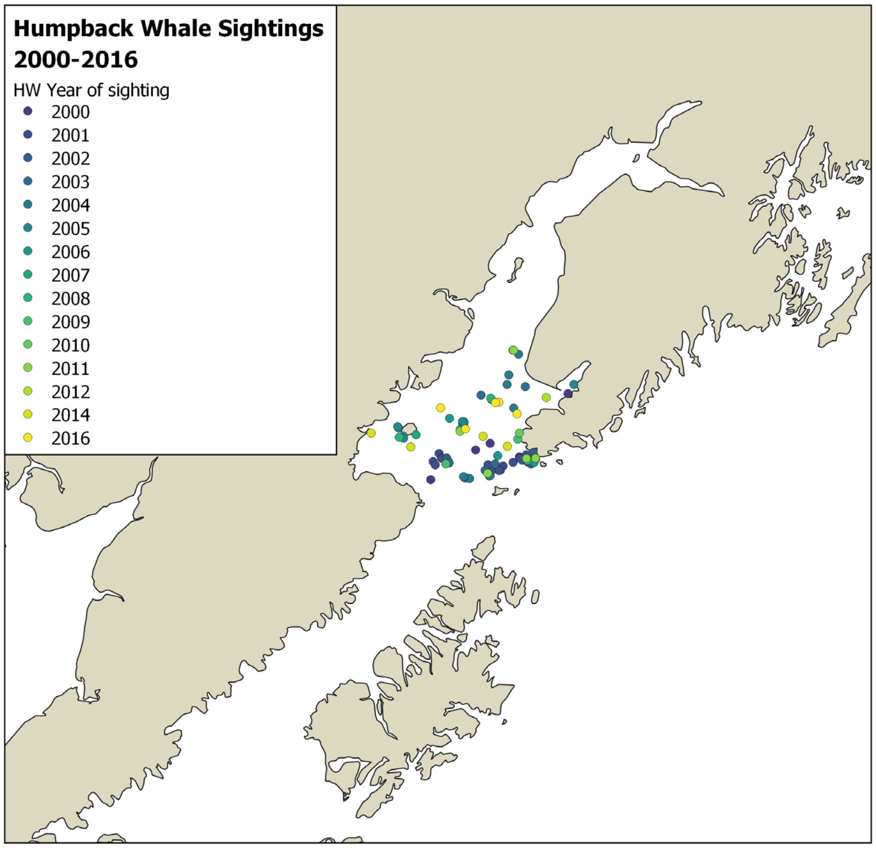

Figure 14. Humpback whale observations during aerial surveys for belugas in Cook Inlet, 2000-2016. (Rugh et al. 2000; Rugh et al. 2005; Shelden et al. 2015a; Shelden et al. 2017; Shelden et al. 2013)

Density data are not available for humpback whales in upper Cook Inlet. Sightings of humpback whales in the project area are rare. Few, if any, humpback whales are expected to approach the project area. However, there were two sightings in 2017 of what was likely a single individual near the Ship Creek boat launch (ABR 2017).

4.3.3.4 Feeding and Prey Selection

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

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

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 et al. 2012). When lunge feeding, whales advance on prey with their mouths wide open, then close their mouths around the prey and trap them by forcing engulfed water out past the baleen plates.

4.3.3.5 Hearing, Vocalizations, and Other Sensory Capabilities

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

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

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 expected 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 discusses the environmental baseline, focusing on existing anthropogenic and natural activities within the action area and their influences on listed species and their critical habitat that may be adversely affected by the proposed action. Although some of the activities discussed below are outside the action area, they may still have an influence on listed species or their habitat in the action area.

The listed species, as well as other resident marine mammal species, may be impacted by a number of anthropogenic activities present in Cook Inlet. The majority of Alaska's population lives in the combined Anchorage/Matanuska-Susitna Boroughs which has led to a higher level of anthropogenic impacts in upper Cook Inlet than is present in most locations in the State. In 2019, 40 percent of Alaska's population was in the Municipality of Anchorage and 15 percent was in the Matanuska-Susitna Borough (Robinson 2020). Anchorage's population is projected to grow by 13,500 people between 2019 and 2045, a 5 percent increase. The Matanuska-Susitna Borough is expected to remain the fastest growing area of the state and its population is projected to increase 44 percent in that same time frame (Robinson 2020). The high level of human activity within upper Cook Inlet has led to multiple paths of potential habitat alteration and/or degradation. Marine mammals may be affected by multiple threats at any given time, compounding the impacts of the individual threats. Anthropogenic risk factors are discussed individually below.

5.1. Coastal Development

Cook Inlet beluga whales and Steller sea lions use nearshore environments to rest, feed, give birth, and breed and thus could be affected by any coastal development that impacts these activities. Humpback whales mostly occupy areas offshore and are less likely to be affected by 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. The largest port and military base in the state are located on the shores of Knik Arm. Activities in Cook Inlet include dredging (e.g., at the Port of Alaska, Ship Creek); pile driving for docks and bridges (e.g., at the Port of Alaska, Ship Creek boat launch, Port MacKenzie, several small projects in the Kachemak Bay area); oil and gas development; laying of communication lines; and installation of pipelines. These activities may affect listed species directly or indirectly by creating noise, altering habitat, or potentially affecting their prey. Significant construction projects in Cook Inlet are discussed in the following sections, many of which have undergone separate section 7 consultations. In this section, we describe the physical aspects of development; noise aspects of development are discussed in Section 5.4.

5.1.1. Road Construction

The Alaska Department of Transportation undertook Seward Highway improvements from Mile 75 to 107 (along Turnagain Arm) beginning in 2015. These activities included geophysical and geotechnical testing, on-shore blasting, pile removal and installation at stream crossings, fill placed into Turnagain Arm, 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.

By the end of 2019, three bridges had been replaced during Phase 1, with the final five planned for Phase 2 beginning in mid-2020. Replacing these bridges included vibratory and impact pile installation and removal of both 24- and 48-inch piles. In-water work on this project was scheduled to not occur from May 15 to June 15 to avoid harassment of Cook Inlet beluga whales during the eulachon run, and any work conducted below mean high water (MHW) required marine mammal monitoring by PSOs. In 2015, NMFS concurred that this Seward Highway Milepost 75 to 90 Bridge Replacement project (including mitigation measures) was not likely to adversely affect Cook Inlet beluga whales.

In 2015, NMFS concurred that the Seward Highway Milepost 105-107 Windy Corner project (including mitigation measures) is not likely to adversely affect Cook Inlet beluga whales. The project will realign the highway and the railroad along 3.2 km (2 mile) segment of the Seward Highway in the vicinity of Windy Corner. In-water effects included land-based blasting and continuous noise from fill placement. The start of this project has been delayed since the consultation was completed. According to the Alaska Department of Transportation website, this project is expected to start construction in the summer of 2021.

In 2020, a consultation was completed for Alaska Department of Transportation for a mitigation project in Portage Creek #2 to compensate for impacts expected to occur from the Seward Highway Improvements project. The proposed project involved the removal of derelict timber piles that once supported a railroad crossing over the river. Mitigation measures included restrictions of timing by season to avoid the peak eulachon and salmon runs, and by day so that work was done during the lowest part of the tidal cycle to minimize the likelihood that belugas would be near the action area. The purpose of the project is to provide beluga whales unrestricted access to this salmon bearing creek. This project is expected to be completed in 2021.

5.1.2. Port Facilities

Cook Inlet is home to port facilities at Anchorage, Point Mackenzie, Nikiski, Kenai, Homer, Seldovia, and Port Graham; barge landings are present at Tyonek, Drift River, and Anchor Point.

Anchorage has a small boat ramp near Ship Creek, which was renovated in 2017. It is the only hardened public access boat ramp in Upper Cook Inlet. However, numerous other boat launch sites (e.g., beach launch at Tyonek, Captain Cook State Recreation Area, City of Kenai boat launch, multiple boat launch locations near the mouth of the Kenai River, and Kasilof River State Recreation Site) provide Cook Inlet access to small boats.

Port of Alaska

The POA (known as Port of Anchorage at that time) Expansion Project (USACE 2009) included pile driving (including sheet and 36-in round piles) and dredging between 2008 and 2011. Cook

Inlet beluga whales were listed under the ESA in October of 2008, therefore, ESA section 7 consultation covered work from 2009 through 2011. NMFS Permits Division authorized 34 takes of belugas per year of the project (there was no take issued for humpback whales or Steller sea lions). The POA reported that 40 beluga whales were observed within the designated 160 dB disturbance zones, and a single Steller sea lion was observed at the facility (ICRC 2012).

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

In 2016, NMFS issued a biological opinion for the POA's Test Pile Program (NMFS 2016a) to evaluate sound attenuation devices for potential use during port expansion projects, including the proposed action in this opinion. The NMFS Permits Division authorized 26 Level B harassment takes for Cook Inlet belugas, and 6 Western DPS Steller sea lions. During the course of this project, belugas entered the Level B exclusion zone on 9 occasions. Only one 4-minute delay of start of operations was necessitated to avoid prohibited takes of belugas, and one authorized instance of Level B harassment occurred, affecting a single whale (Cornick and Seagars 2016).

In 2018, NMFS issued a Letter of Concurrence for the POA Fender Pile and Replacement Repair project (NMFS 2018c). This project included pile driving of 44 22-in round piles. Mitigation measures were implemented to avoid take of marine mammals, therefore no take was authorized. No sightings of protected species occurred during pile driving activities. However, on May 30, 2019, a small group of belugas was observed by the construction crew before in water work began. When the PSO arrived, they observed three adults traveling north and milling.

The Port of Alaska Modernization Program (PAMP) includes multiple construction projects to update facilities for operational efficiency, accommodate modern shipping operations, and improve seismic resiliency. Phase 1 of the PCT which was completed in 2020, included an access trestle which required that steel piles be driven 100 to 130 feet into the sea floor. Construction began with onshore preparation and staging activities in March of 2020 and was completed in November 2020. Fifty-five level B harassment takes for Cook Inlet beluga whales were authorized for this project and 26 potential Level B takes were recorded; 3 in June, 12 in August, 3 in September, and 8 in November (61 North Environmental 2021a). Phase 2 of the PCT began in the spring of 2021. For this portion of the project, 35 Level B harassment takes of Cook Inlet beluga whales were authorized. Installation of the first 144" monopile occurred on May 26, 2021. For the period of April 26- May 30, 2021, 78 Cook Inlet beluga whales were sighted in 23 groups. Seven potential Level B takes of Cook Inlet beluga whales occurred during installation of the 144" piles in this timeframe. From May 31 to June 27, 2021, an additional 3 potential Level B takes occurred for a cumulative total of 10 through the end of June 2021 (61 North Environmental 2021b). The last in-water work that remains for Phase 2, is the removal of the template piles. They are scheduled for removal in the first weeks of August, 2021.

In 2020 the POA applied for a Nationwide Permit 3, Maintenance (NWP3) for the POA Fender Pile Replacement and Repair Project. The purpose of the project is to replace piles within the

POA's existing fendering system. Pre- and post-earthquake (2018) inspections showed that these 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. A total of 23 fender assemblies were replaced in 2015 (described above, Terminal 3 Repair) and 2019 (described above, Fender Pile and Replacement Repair project). The POA plans to repair the remaining 84 fender assemblies via installation of 168, 22-inch pin piles (2 piles per fender). Shipping schedules - including cruise, cargo, fuel, cement, and military vessels - allow for only one or two fenders to be repaired each week. The POA anticipates that 34 fenders will be replaced annually in the first two years, beginning in 2022, and 16 the third year.

In order to reinforce each fender assembly, a new 22-inch steel pile would be installed inside of each existing 24-inch pile up to a 45-foot embedment depth using an impact and/or vibratory hammer. For piles that are determined to be in extremely poor condition or that have already failed, a diver would cut the pile off at the mudline and remove the non-embedded portion of the pile. This scenario may occur with 25 to 50 percent of the new piles. In-water work would include pile installation and fender repair within previously disturbed areas; no excavation or fill is associated with this project. NMFS completed a Letter of Concurrence for the fender repair project in 2021; however, work will not begin until 2022.

The USACE has been conducting maintenance dredging annually at the Port of Alaska since 1965. The POA is dredged to the depth of minus 35 feet mean lower low water (MLLW). Dredged materials are dumped 3,000 feet abeam of the POA dock face at the Anchorage in-water disposal site. NMFS issued a Letter of Concurrence most recently in 2017.

In 2018, NMFS issued a Letter of Concurrence for the POA to conduct transitional dredging at the existing Terminal facility and dredged material disposal offshore. Dredging at the POA has not been identified as a source of re-suspended contaminants (USACE 2009), and belugas often pass near the dredge (ICRC 2012; POA 2019; USACE 2008; USACE 2019).

Dredging operations also occur annually at the Ship Creek Boat Ramp, located approximately 1.4 km (0.8 mi) southwest of the POA SFD project location. The dredging at this site is done in three to four days during minus 3-foot tides when the area is dewatered. Heavy machinery pushes the accumulated sediment around the boat ramp seaward. A Letter of Concurrence was written for the Ship Creek dredging in May 2020.

Port MacKenzie

Port MacKenzie is along western lower Knik Arm. Coastal development at this site began in 2000 with the construction of a barge dock. Additional construction and bulkhead repair activity has occurred since then. Port MacKenzie currently consists of a 152 m (500 ft.) bulkhead barge dock, a 366 m (1,200 ft.) deep draft dock with a conveyor system, a landing ramp, and more than 8,000 acres of adjacent uplands. The seawall to this port has failed twice (in the winter of 2015-2016 and 2016-2017), necessitating emergency pile driving and other repair measures to avoid additional loss of fill and damage to sheet piles. Emergency consultations occurred after much of the repair work had been completed. NMFS concluded that the emergency work did not adversely affect listed species.

Other Ports

The Drift River Terminal facility in Redoubt Bay is used primarily as a loading platform for shipments of crude oil collected from several fields and platforms at Drift River. The docking facility there is connected to a shore-side tank farm and is designed to accommodate tankers in the 150,000 deadweight-ton class. The Drift River Terminal had an original storage capacity of up to six million gallons of crude oil and in 1989-1990 it was storing 900,000 barrels of crude. In 2009, a volcanic eruption of Mt. Redoubt forced the evacuation of the terminal and a draw-down of oil stored on-site (Alaska Journal of Commerce 2009). Hilcorp bought the facility in 2012 and, after numerous improvements, partially reopened the facility to oil storage and tanker loading operations. However, Hilcorp is currently in process of decommissioning the Drift River Terminal. Decommissioning would require the installation of additional pipelines in Cook Inlet.

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

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. Eley (2012) estimated that large ship port calls could increase by 40 percent (200 ships per year) with the construction of the Alaska Liquefied Natural Gas pipeline and full development of Port MacKenzie and Ladd's Landing (Eley 2012).

In summary, coastal development may affect Cook Inlet beluga whales, humpback whales, and Steller sea lions directly or indirectly when new construction occurs (loss of habitat, noise), as a result of increased vessel traffic from port improvements and expansion (ship strike, noise) or from the increased likelihood of contaminants entering Cook Inlet as a consequence of expanded commercial and industrial activities adjacent to the marine environment.

5.2. Oil and Gas Development

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

Lease sales for oil and gas development in Cook Inlet began in 1959 (Alaska Department of Natural Resources 2014). Prior to the lease sales, there were attempts at oil exploration along the west side of Cook Inlet. By the late 1960s, 14 offshore oil production facilities were installed in upper Cook Inlet, and most of the Cook Inlet platforms and much of the associated infrastructure is now over 40 years old. Today, there are 17 offshore oil and gas platforms in Cook Inlet. Figure

16 shows the ongoing oil and gas activities in state waters as of May 2019. Active oil and gas leases in Cook Inlet total 211 leases encompassing approximately 450,412 acres of State leased land of which 311,265 acres are offshore (Alaska Department of Natural Resources 2020)[10] (Figure 17).

In 2017, BOEM held Lease Sale #244 in Cook Inlet. Hilcorp was the only company responding, submitting bids on 14 of 224 tracts/Blocks offered; their successful bids encompass 31,005 acres. In 2019, NMFS issued Incidental Take Regulations for Hilcorp's oil and gas activities in Cook Inlet (NMFS 2019), including seismic surveys, and other exploration and development activities within these blocks. These seismic surveys are discussed further below.

Oil and gas development is still ongoing in Cook Inlet as two companies, HEX Group and Strong Energy Resources successfully bid on nearly 21,000 acres of oil and gas tracts in Cook Inlet the week of June 7, 2021. About 3.3 million acres were up for bid in this sale for state-owned leases. This year's federal oil and gas sale in Cook Inlet is on pause due to a temporary hold on federal leasing programs nationwide.

Kenai Liquid Natural Gas Plant

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

Based on existing active leases and estimates of undeveloped oil and gas resources, oil and gas development will likely continue in Cook Inlet; however, the overall effects on listed marine mammals are unknown (NMFS 2008a; NMFS 2008b). 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).

[10] http://dog.dnr.alaska.gov/documents/leasing/periodicreports/lease_lasactiveleaseinventory.pdf; accessed 1/22/2020

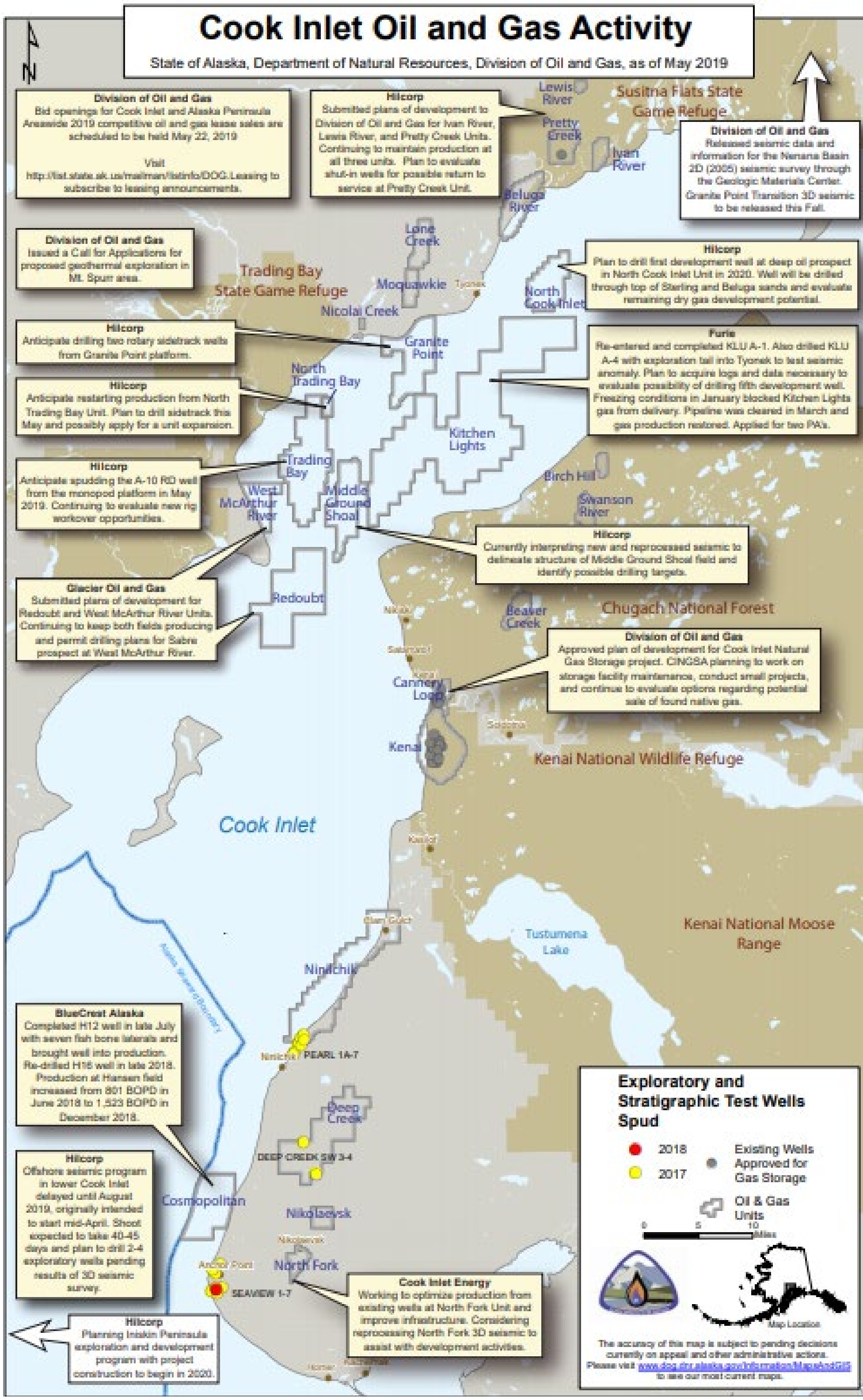

Figure 15. Oil and gas activity in Cook Inlet as of May, 2019.

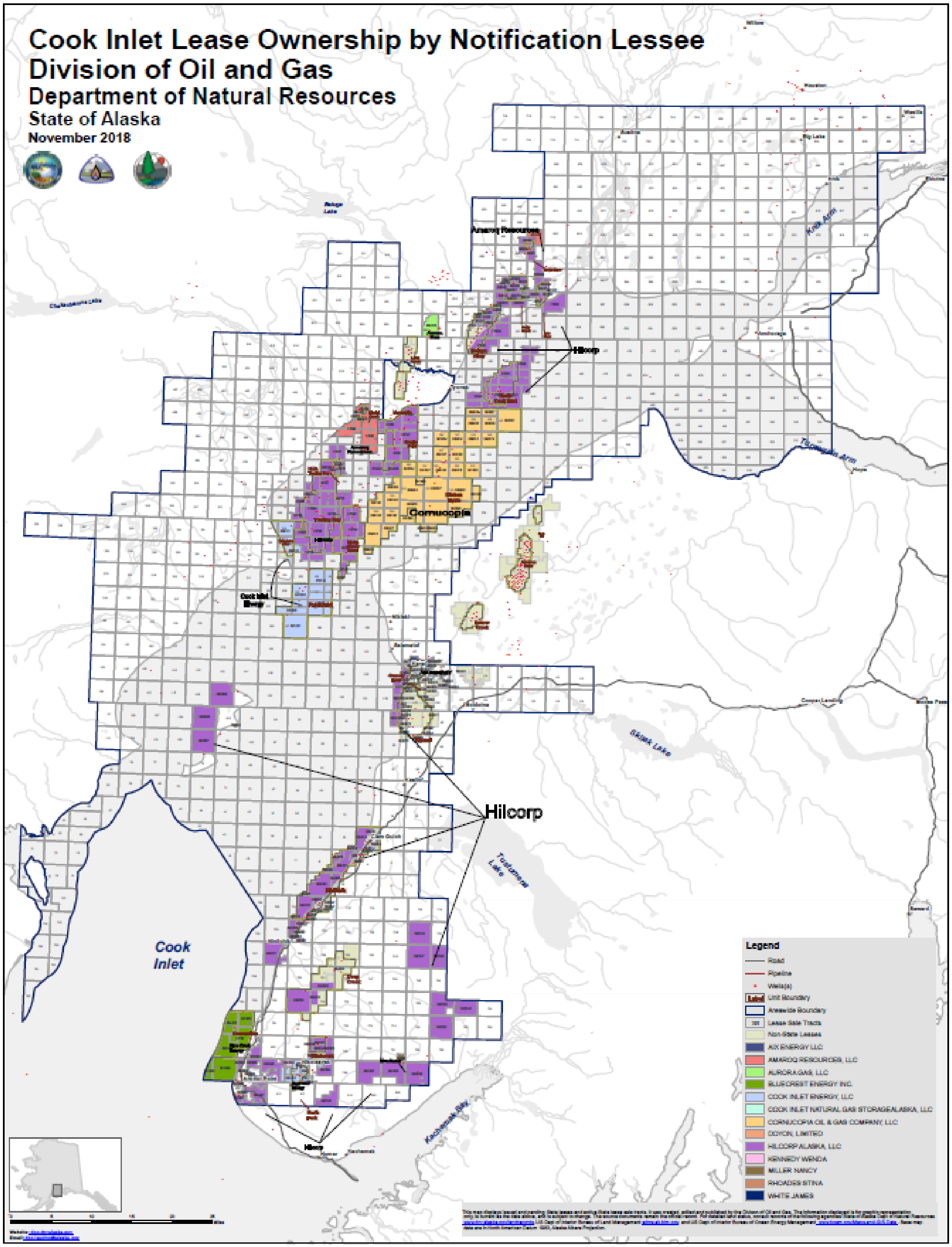

Figure 16. Cook Inlet Lease Ownership by Notification Lessee
http://dog.dnr.alaska.gov/Documents/Maps/CookInlet_NotificationLesseNov2018_Labeled.pdf

5.3. Underwater Installations

The majority of underwater installations in Cook Inlet are oil and gas pipelines. The Cook Inlet basin is the source for all natural gas used in south-central Alaska. Pipelines are an essential part of oil and gas activities in Cook Inlet (Figure 18). However, communication cables have also been laid and a project to harness tidal energy is the initial stages of development.

Installation of pipelines involves multiple vessels because a trench is dug and then the pipeline is assembled and laid in the trench using a pipe-laying barge. This is a non-motorized barge that is moved by picking up and resetting anchors that are used to hold it in place while pipe is welded together and laid over the back of the barge. Anchor-handling tugs employing bow-thrusters are used to reposition the anchors and keep the barge properly positioned and moving along. Consequently, these projects involve disturbance to the substrate, increased turbidity in the vicinity of the trenching, and increased noise from the tugboats and pipelaying 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 are discussed in 5.5.1 Petrochemical spills and contaminants are discussed in 5.5.7 Contaminants Found in Listed Species.

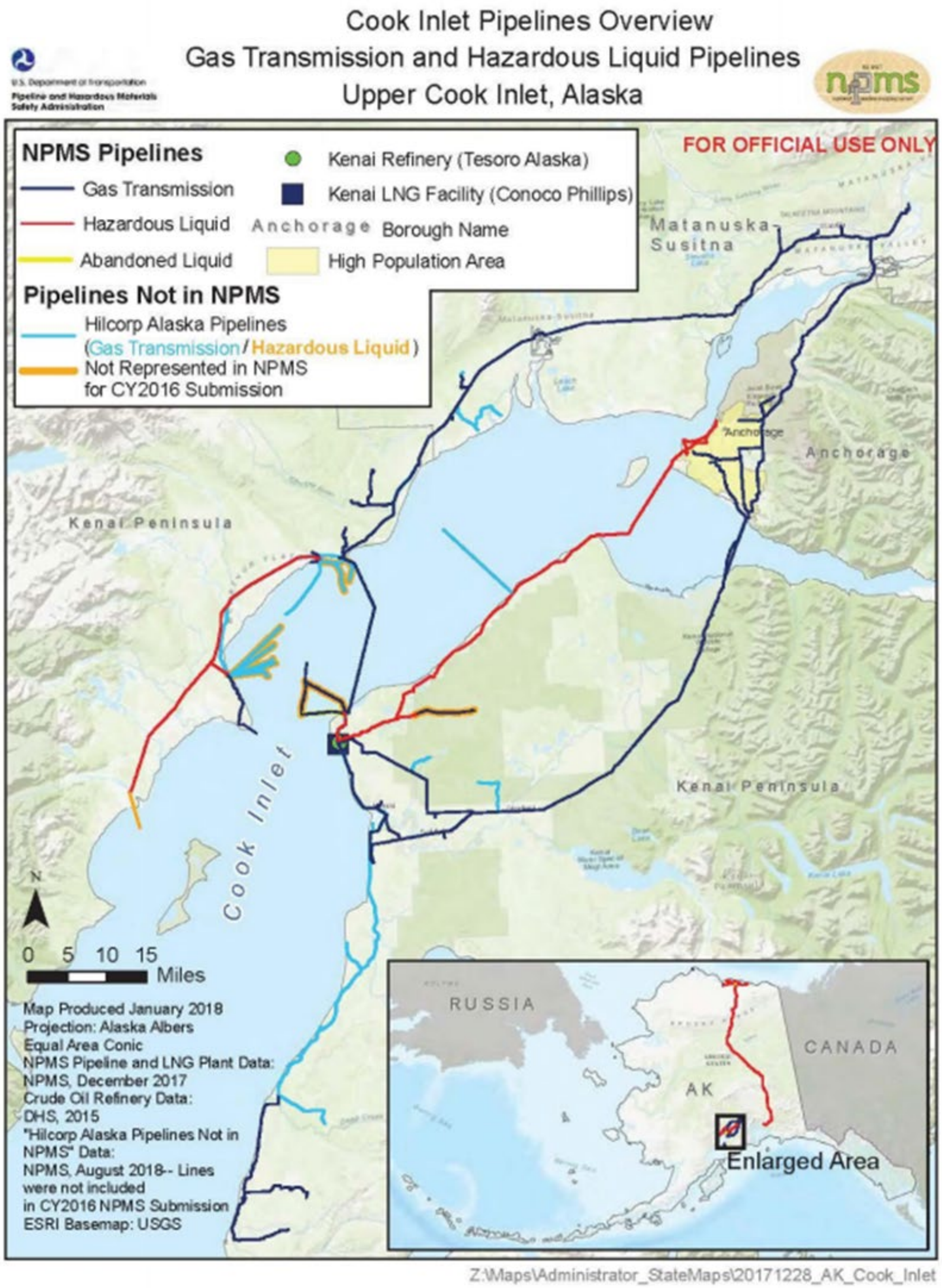

Figure 17. Pipelines in Cook Inlet.

Trans-Foreland Pipeline

In 2014, the Trans-Foreland Pipeline Co. LLC (owned by Tesoro Alaska) received approval from state, Federal (including NMFS section 7 AKR-2014-9394), and regional agencies to build a 46.7-km (29-mi) long, 20.3-cm (8-in) diameter oil pipeline from the west side of Cook Inlet to the Tesoro refinery at Nikiski and the Nikiski-Kenai Pipeline company tank farm on the east side of Cook Inlet. The pipeline will be used by multiple oil producers in western Cook Inlet, to replace oil transport by tanker from the Drift River Tank farm. Horizontal directional drilling will be used at nearshore locations at the East and West Forelands to install the pipeline.

Hilcorp Cook Inlet Pipeline Cross Inlet Extension

In 2018, NMFS issued an IHA to Harvest Alaska, LLC (Harvest), associated with their plans to extend their existing undersea pipeline network to connect their Tyonek platform to the land-based Tyonek/Beluga, Alaska, pipeline at a point about 4 miles (6.4 km) north of the village of Tyonek. The IHA authorized the incidental take, by Level B harassment, of 40 Cook Inlet beluga whales, 6 Steller sea lions, and 5 humpback whales (NMFS 2018b). This project was completed in 2018 (Sitkiewicz et al. 2018).

Alaska LNG Project

The Alaska LNG Project is designed to carry natural gas from the North Slope to southcentral Alaska and for export internationally. Proposed infrastructure includes an 800-mile long, large diameter pipeline from the North Slope that would cross Cook Inlet north of the Forelands and terminate at a liquefaction facility proposed at the Nikiski area on the Kenai Peninsula. This project could eventually ship up to 2.4 billion cubic feet of LNG per day. The Alaska Gasline Development Corporation (AGDC) has applied for MMPA authorization for the Cook Inlet portion of the project, and the Federal Energy Regulatory Commission issued a Draft Environmental Impact Assessment in June 2018. Although a biological opinion was completed for this project in 2020(NMFS 2020) and construction was proposed to begin in 2021, work has not begun. Five years of construction are anticipated in the Cook Inlet portion of the project. The project is expected to result in Level B harassment of 61 Cook Inlet beluga whales, one Level A and one Level B harassment of the Mexico DPS humpback whales, and one Level B harassment of Western North Pacific DPS humpback whales. No effects to Steller sea lions are anticipated.

Telecommunications

In 2009, Alaska Communications Systems Group, Inc. (ACS) installed a fiber optic cable from Florence, Oregon to Anchorage, Alaska to improve communication between Alaska and the rest of the United States. The portion the fiber optics cable that is located in the action area is the submarine cable that extends from Nikiski on the Kenai Peninsula to Point Woronzof in Anchorage. Potential impacts from the fiber optic cable included a temporary increase in vessel traffic and noise during the installation of the cable. During installation, vessels generally operated at speeds of 1-2 kn as the cable was buried 1.2 m (3.9 ft) below the seafloor (ACS 2008). After installation, the fiber optic cable rests along the seafloor with a minimal footprint.

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 the Federal Energy Regulatory Commission in May 2021 for a project in Cook Inlet. ORPC proposes to install a tidal energy generation project at East Foreland, Cook Inlet, Alaska. Once the project is functioning, ORPC will collaborate with Homer Electric Association, Inc. (HEA) to sell the tidal energy produced. Because of the huge tidal swings, ORPC considers Cook Inlet to be the premiere tidal resource in the United States.

ORPC intends to develop a 5 MW 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 MW commercial-scale project[11]. ORPC has previously conducted site characterization and environmental studies in the region.

5.4. Natural and Anthropogenic Noise

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

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

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

5.4.1. Seismic Surveys in Cook Inlet

Cook Inlet has a long history of oil and gas activities including seismic exploration, geophysical and geological (G&G) surveys, exploratory drilling, vessel and air traffic, and platform production operation. Seismic surveys use high energy, low frequency sound in short pulse durations to characterize subsurface geology (Richardson et al. 1995a) often to determine the location of oil and gas reserves. Geophysical seismic activity has the potential to harass or harm marine mammals (Nowacek et al. 2015).

A seismic program occurred near Anchor Point, Alaska, in the fall of 2005. Geophysical seismic operations were conducted in Cook Inlet during 2007, near Tyonek, East and West Forelands, Anchor Point, and Clam Gulch. Additional small seismic surveys were conducted in Cook Inlet

[11] https://www.homerelectric.com/2021/05/orpc-plans-to-advance-tidal-energy-in-cook-inlet/

during 2012. From 2013 to 2015 approximately 3,367 km^2 (1,300 mi^2) of three-dimensional (3D) and 40,000 km (25,000 mi) of two-dimensional (2D) seismic line surveys were conducted in Cook Inlet (Figure 19). A large seismic program took place in 2013 and 2014; data were collected between Anchorage and Anchor Point. Another large seismic survey took place in 2015 and 2016 in Cook Inlet between Beluga, Alaska, and across Cook Inlet to Salamatof, Alaska, and along the eastern inlet between Kalifornsky, Alaska, and south to Anchor Point. More recently, Hilcorp conducted a 3D seismic survey in lower Cook Inlet in September 2019.

Because of the generally shallow water and the increased use of ocean-bottom cable and ocean-bottom node technology seismic surveys in Cook Inlet are able to use relatively small airgun arrays (Rigzone 2012). Over the last 15 years surveys have used maximum airgun arrays of 1,760 and 2,400 in^3 with source levels of about 237 dB re 1 $\mu Pa_{RMS.}$ Shallow water surveys have involved 440, 620, and 880 in^3 arrays with source sound pressure levels less than 230 dB re 1 μPa_{RMS}. Measured radii to Level B (160 dB) harassment isopleths have ranged from 3 to 9.5 km (1.8-5.9 mi).

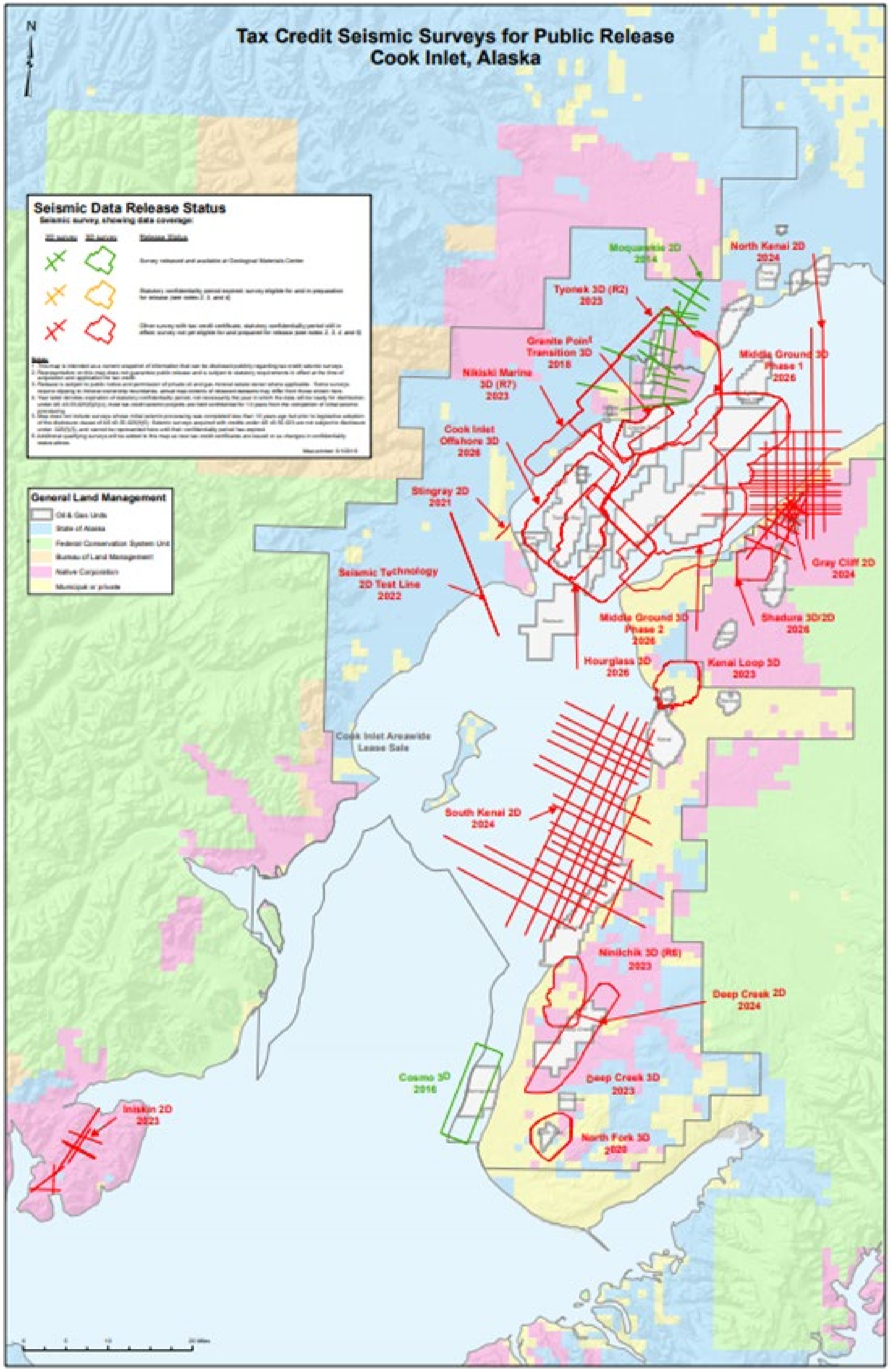

Figure 18. Seismic surveys in Cook Inlet. Dates indicate year technical data is scheduled for release. [12]

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

Apache Seismic Exploration (2012-2014)

In the course of 1,800 hours of seismic activity in 2012, Apache Alaska Corporation (Apache) reported zero takes of either beluga whales or Steller sea lions; although some protected marine mammals were observed within zones ensonified to greater than 120 and 160 dB prior to powering down or shutting down of equipment. The company experienced five delays resulting from ensuring no marine mammals were in the 160 dB disturbance zone, six shutdowns, one power-down, one shutdown followed by a power-down, and one speed and course alteration (Lomac-MacNair et al. 2013).

In 2014, despite implementing a total of 13 shutdowns and 7 ramp-up delays for marine mammals, observers recorded a total of 29 takes (12 beluga whales, 6 harbor porpoise, 9 harbor seals, and 2 humpback whales) from noise exposures (25 at ≥160 dB_{RMS} and 4 at ≥180 dB_{RMS}) (Lomac-MacNair 2014). Also during Apache's 2014 operations, four groups of beluga whales occurred less than 500 m from the Apache source vessel during seismic operations (Lomac-MacNair et al. 2014). The report does not state whether seismic guns were firing at this time. If these close approaches by belugas occurred during operation of the 1,760 in^3 airgun array that was being used, that would represent 4 groups of belugas (of unstated group size) subjected to Level A take (Level A take isopleth for 1,760 in^3 array for cetaceans = 1,840 m).

NMFS is aware of at least one humpback whale having been observed and possibly taken in upper Cook Inlet (by harassment and/or injury) by Apache's seismic operations on April 25, 2014, by the M/V *Peregrine Falcon* operating a 1,760 in^3 airgun array at full volume. The humpback whale was first observed 1.5 km (0.9 mi) from the sound source at a time when all whales within 1.84 km (1.1 mi) of the sound source would have been exposed to MMPA Level A take (sound impulses in excess of 180 dB). Although seismic operations were shut down immediately after observing this animal, the whale apparently was exposed to full volume seismic impulses during the time it transited from 1.84 km to 1.5 km (1.1 mi to 0.9 mi) from the sound source. Assuming seismic shots were fired at 15 second intervals and assuming the whale traveled directly towards the source at the average cruising speed of a humpback whale (4.0 km/hour [2.5 mi/hour]) (Noad and Cato 2007), then this whale would have been exposed to at least 19 shots while it was within the exclusion zone prior to shut-down; 19 shots exceeding the 180 dB threshold for Level A take[13].

SAE 3D Seismic Exploration (2015)

Seismic operations took place in upper Cook Inlet; they began on 15 May 2015 and continued until 27 September 2015. Eight vessels operated during the surveys including two seismic source vessels, the M/V *Arctic Wolf* and M/V *Peregrine Falcon*, and one mitigation vessel, the M/V *Westward Wind*. Seven PSOs were stationed on the source and mitigation vessels, including two

[13] This project occurred prior to the issuance of the new Level A guidance NMFS. 2018a. 2018 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. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59., and references the old 180/190 Level A thresholds.

on each source vessel, and three on the mitigation vessel. PSOs monitored from the vessels during all daylight seismic operations and most daylight non-seismic operations.

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

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

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

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

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

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

<u>Hilcorp 3D Seismic – Lower Cook Inlet, OCS (2019)</u>

Hilcorp conducted a 3D seismic survey from September 10-October 17, 2019 in Lower Cook Inlet, comprised of approximately 790 square kilometers (km^2) over 8 Outer Continental Shelf (OCS) lease blocks. The seismic survey included four vessels: one source, two support, and one for marine mammal mitigation. PSOs were stationed onboard the source (Polarcus *Alima*) and mitigation (R/V *Q105*) vessels. Daily aerial surveys were conducted with a fixed- wing, high-wing P68C aircraft based in Homer, Alaska, that flew east-west transects over the seismic activity area. The sightings during the seismic project are presented in Table 5.

Table 6. Sightings of ESA-listed marine mammals during Hilcorp's 2019 seismic surveys in Lower Cook Inlet.

ESA-listed species	# of sightings[1]	Estimated # of Individuals[2]	Project Level B Exposures[4]
Fin whale	8	23	10.9
Humpback whale[3]	14	38	31.5
Beluga whale	2	2	0
Steller sea lion	5	5	4.9

[1] One sighting equals one group.
[2] Totals do not include re-sightings.
[3] Includes both Western North Pacific and Mexico DPS.
[4] Based on actual take + estimated take.

5.4.2. Oil and Gas Exploration, Drilling, and Production Noise

The greatest noise levels from drilling platforms originate from operating noises from the oil platform, not from the noise generated by drilling, with frequencies generally below 10 kHz. In general, noise from the platform itself is thought to be very weak because of the small surface area (the four legs) in contact with the water (Richardson et al. 1995b) and that the majority of the machinery is on the deck of the platform, which is above the water surface. However, noise carried down the legs of the platform likely contributed to the higher noise levels than expected (Blackwell and Greene 2003). Blackwell and Greene (2003) recorded underwater noise produced at Phillips A oil platform (now the Tyonek platform) at distances ranging from 0.3 to 19 km (0.2 to 12 mi) from the source. The highest recorded sound level was 119 dB at a distance of 1.2 km (0.75 mi). Noise between two and 10 kHz was measured as high as 85 dB as far out as 19 kilometers from the source. This noise is audible to beluga, humpback, and fin whales and Steller sea lions.

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

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

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

Actions associated with Furie's proposed activity include transport of a jack-up rig, the *Randolph Yost*, by up to three tugs to the drilling sites, high-resolution geophysical surveys, pile driving at each drilling location, drilling operations, vessel and air traffic associated with rig operations, fuel storage, and well completion activities. NMFS completed consultation on this action in 2017 (NMFS 2017a). Thereafter, NMFS completed an informal consultation on the updated action, concurring that that action was not likely to adversely affect listed species or critical habitat (with no take authorized).

Hilcorp Oil and Gas
In addition to the seismic survey discussed above, the Hilcorp Incidental Take Regulations issued in 2019 included oil and gas exploration, development, production, and decommissioning activities in Cook Inlet, Alaska between June 1, 2019 and June 1, 2024. Hilcorp plans to conduct the exploratory drilling program April to October between 2020 and 2022. The exact start date is currently unknown and is dependent on the results of the seismic survey, geohazard survey, and scheduling availability of the drill rig. It is expected that each well will take approximately 40 to 60 days to drill and test. Hilcorp plans to drill two and as many as four exploratory wells, pending results of the 3D seismic survey in the lower Cook Inlet OCS leases. After testing, the wells may be plugged and abandoned.

5.4.3. Construction and Dredging Noise

Pile driving and dredging are the primary sources of construction noise in Cook Inlet. The Port of Alaska is dredged annually and construction noise from pile driving is the primary noise source from the proposed activities in this opinion.

Port MacKenzie, located just two miles away across Cook Inlet, has also undergone recent renovations and multiple emergency repairs requiring pile driving, including removal and installation of sheet piles as was discussed in section 5.1.2 (NMFS 2017b).

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

Small and/or private docks also may utilize pile driving as a part of their expansions or repairs (e.g., the OSK dock in Nikiski was approved to be upgraded and expanded in 2012). Repair of sewage lines and construction of dock facilities occurred during the time that this project took place; activities that introduced noise to the marine environment. However, there was no documentation of noise levels from this repair work.

5.4.4. Vessel Traffic Noise

Cook Inlet is a regional hub of marine transportation throughout the year, and is used by various classes of vessels, including containerships, bulk cargo freighters, tankers, commercial and sport-fishing vessels, and recreational vessels. Vessel traffic density in Cook Inlet is concentrated along the eastern margin of the Inlet between the southern end of the Kenai Peninsula and north to Anchorage (Figure 20). Oil produced on the western side of Cook Inlet is transported by tankers to the refineries on the east side. Decommissioning of the Drift River Terminal (included as a component activity covered by the Hilcorp ITRs) would eliminate one substantial source of tanker traffic in Cook Inlet.

Two of the vessels that make regular calls to the POA, the *Midnight Sun* and the *North Star*, are 53,000-horsepower, 839-foot cargo ships that pass through Cook Inlet at 15 to 20 knots four times per week, equaling 208 transits per year (Eley 2012). Blackwell and Greene (2003) observed that beluga whales “did not seem bothered” when the whales were travelling slowly within a few meters of the hull and stern of the moored cargo-freight ship *Northern Lights* in the Anchorage harbor area. They speculated that in areas where belugas are subjected to perennial boat traffic, they may habituate and become tolerant of the vessels. However, noises from ships and other activities in Cook Inlet may cause a decrease or cessation of beluga vocalizations, or mask their vocalizations (Castellote et al. 2015).

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

Steller sea lions and humpback whales may exhibit varying reactions to the presence of vessels, ranging from attraction (especially if animals are habituated to vessels as a source of food) to avoidance. Some vessels, such as tugs towing barges or oil rigs, can produce sound capable of harassing marine mammals located over 2 km from the source (Jacobs Engineering 2017b).

The large variety of vessels in Cook Inlet from small recreational skiffs to containerships creates a soundscape very different from the environment in which beluga whales evolved. Scheifele et al. (2005) studied a population of belugas to determine whether beluga vocalizations showed intensity changes in response to shipping noise. Scheifele et al. (2005) demonstrated that shipping noise did cause belugas to vocalize louder. Lesage et al. (1999) described more persistent vocal responses when whales were exposed to a ferry than to the small-boat noise. These included 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 used by vocalizing animals when vessels were close to the whales. The fact that belugas alter their vocal behavior by increasing the intensity or repetition rate, or by shifting to higher frequencies when exposed to shipping noise (from merchant, whale-watching, ferry and small boats), is indicative of an increase of energy costs (Bradbury and Vehrencamp 1998). If noise exposure is chronic, long-term adverse energetic consequences could occur. 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 2016).

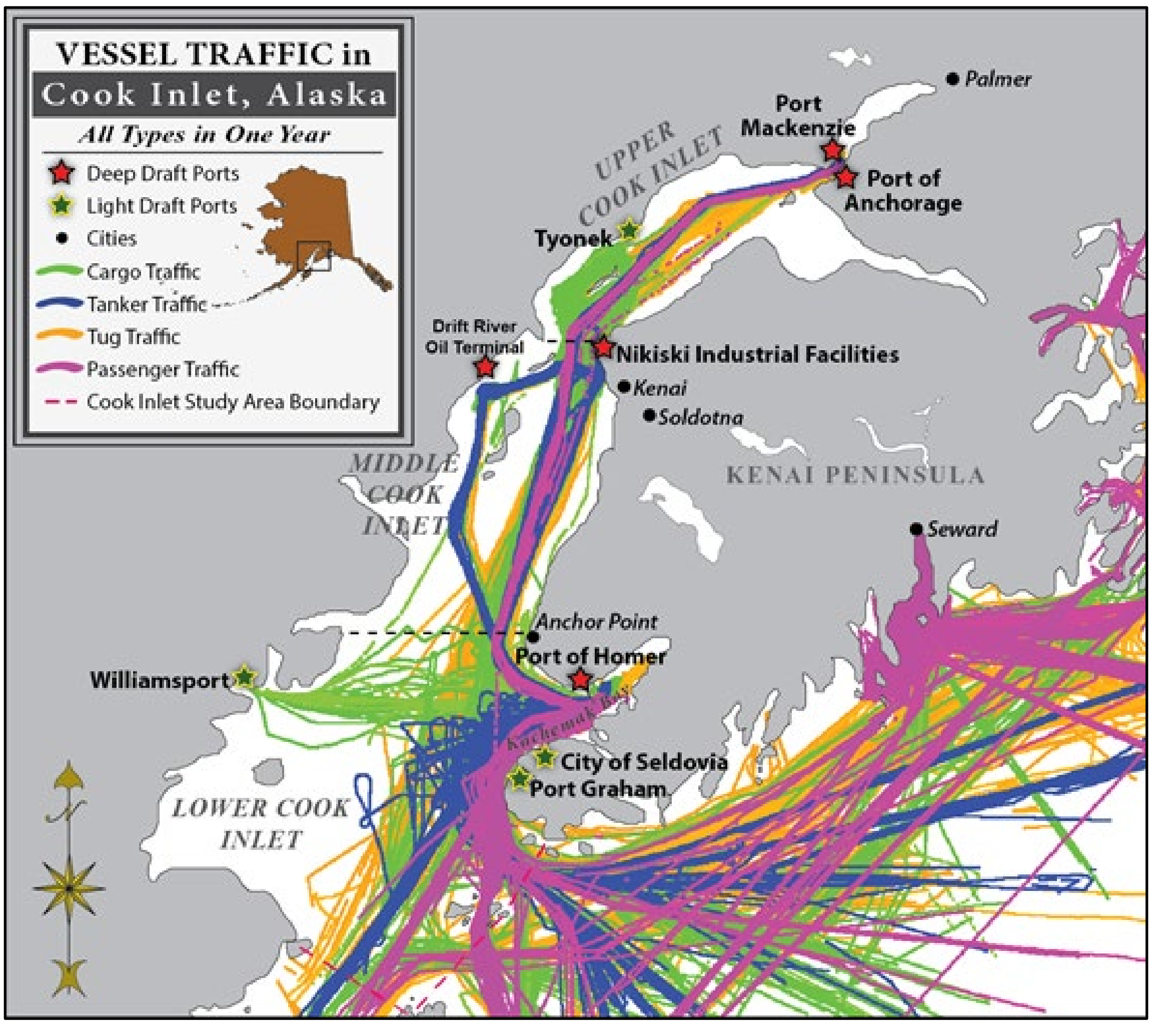

Figure 19. Summary of Cook Inlet Vessel Traffic by Vessel Type (Cape International, Inc. 2012, BOEM 2017b). Only vessels more than 300 gross tons are shown.

5.4.5. Aircraft Noise

The airspace above Cook Inlet experiences significant levels of aircraft traffic. Ted Stevens International Airport in Anchorage is directly adjacent to lower Knik Arm and receives high volumes of commercial air traffic. It is also the second largest air cargo hub in the United States. Joint Base Elmendorf Richardson also has a runway near and airspace directly over Knik Arm. Lake Hood in Anchorage is the world's largest and busiest seaplane base and the only seaplane base with primary airport status in the U.S. (Federal Aviation Administration 2016). Other small public runways are found at Birchwood, Goose Bay, Merrill Field, Girdwood, the Kenai Municipal Airport, Ninilchik, Homer, and Seldovia. Oil and gas development projects often involve helicopters and fixed-winged aircraft, and aircraft are used for surveys of natural resources including Cook Inlet beluga whales. Airborne sounds do not transfer well to water because much of the sound is attenuated at the surface or is reflected where angles of incidence are greater than 13°; however, loud aircraft noise can be heard underwater when aircraft are within or near the 13º overhead cone and surface conditions are calm (Richardson et al. 1995b).

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

The noise and visual presence of aircraft can result in behavioral changes in whales such as diving, altering course, vigorous swimming, and breaching (Patenaude et al. 2002). Aircraft can also result in disturbance to Steller sea lions, especially if they are hauled out on land. Disturbance on a rookery or haulout could easily lead to serious injury or death, mainly due to trampling. MML scientists reported an event where over 1,000 sea lions stampeded off a beach in response to a large helicopter over 1 mile away (Withrow 1982). However, there are no rookeries or haulouts within Cook Inlet.

5.5. Water Quality and Water Pollution

Potential sources of pollutants in Cook Inlet include: (1) discharge from industrial activities; (2) discharge from community wastewater treatment facilities; (3) runoff from urban, agriculture, transportation, and mining sources; (4) accidental spills or discharge from oil and gas production; and (5) ballast water discharges (Moore et al. 2000; NMFS 2008a). Main sources of pollutants found in Cook Inlet likely include the 10 wastewater treatment facilities, stormwater runoff, airport deicing effluents, products created by military training at Eagle Bay, and accidental discharge from oil and gas development (Moore et al. 2000; NMFS 2008a).

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

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

The Cook Inlet region is the most populated and industrialized region of the state. Its waters receive various pollutant loads through activities that include urban runoff, oil and gas activities (e.g., discharges of drilling muds and cuttings, production waters, treated sewage effluent discharge, deck drainage), municipal sewage treatment effluents, resuspension of contaminants through dredging, oil and other chemical spills, fish processing, and other regulated discharges. 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 either the Environmental Protection Agency (EPA) or the ADEC, who may authorize certain discharges under the National (or Alaska) Pollution Discharge Elimination System (NPDES/APDES; section 402 of the CWA of 1972).

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

Cook Inlet beluga whales are exposed to chemical concentrations that are typically lower than those experienced by other Arctic marine mammals (Becker et al. 2000; Becker et al. 2010). Levels of heavy metals, pesticides, petroleum hydrocarbons, and polychlorinated biphenyl (PCB) compounds found in Cook Inlet's water column and sediments were below detection limits; and heavy metal concentrations were below management levels (KABATA 2004; NMFS 2008a; USACE 2008).

5.5.1. Petrochemical spills

Given the amount of oil and gas production and vessel traffic, spills of petroleum products are a threat to marine mammals inhabiting Cook Inlet. Research indicates cetaceans are capable of detecting oil, but they do not seem to avoid it (Geraci and St. Aubin 1990). Oil spills that occur in tributary streams to Cook Inlet could result in marine mammals experiencing direct contact with the oil, with possible effects to skin and/or respiratory systems. Cook Inlet beluga whales could be affected through residual oil from a spill, even if they were not present during the oil spill, due to the highly mobile nature of oil in water and the extreme tidal fluctuations in Cook Inlet (NMFS 2008a). Prey contamination is also possible but Saupe et al. (2014) in a study of winter prey items for Cook Inlet belugas found non-detectable levels of hydrocarbons. In the event of a large spill, clean-up efforts could result in displacement of whales from essential feeding areas.

Oil has been implicated in the deaths of pinnipeds, including Steller sea lions (St. Aubin 1990). Pinnipeds exposed to oil at sea through incidental ingestion, inhalation, or limited surface contact do not appear greatly harmed by the oil; however, pinnipeds found close to the source or who must emerge directly in oil are substantially more affected. Toxic substances, such as oil, may be a contributing factor in the decline of the Western DPS Steller sea lion population (NMFS 2008b). Sea lions exposed to oil through inhalation, dermal contact and absorption, direct ingestion, or through the ingestion of prey may become heavily contaminated with polycyclic aromatic hydrocarbons (PAHs).

The Exxon Valdez oil spill occurred after the Steller sea lion population decline began and may have contributed further to the decline in the local area. Mortalities from toxic contamination were strongly linked to this spill. Twelve sea lion carcasses were found in Prince William Sound, and 16 carcasses were found near Prince William Sound, along the Kenai coast, and at the Barren Islands. Elevated PAH levels were present in the animals found dead shortly after the spill (NMFS 2008b).

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

It is not known whether 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.

According to the ADEC's oil spills database, oil spills in marine waters consist mostly of harbor and vessel spills, and spills from platform and processing facilities. A reported 477,942 liters (126,259 gal) (from 79 spills) of oil was discharged in the Cook Inlet area since July 1, 2013, primarily from vessels and harbor activities and from exploration and production facilities. Three of the ten largest spills in Alaska during state fiscal year 2014 occurred in Cook Inlet; these included 84,000 gallons of produced water by Hilcorp in the Kenai gas field; 9,100 gallons of process water released by the Tesoro API Tank Bypass Spill; and a Flint Hills, Anchorage spill of 4,273 gallons of gasoline (ADEC 2015).

A spill baseline study conducted as part of the Cook Inlet Risk Assessment estimated a historical vessel spill rate of 3.4 spills (regardless of size) per year, with 3.9 spills per year forecasted for the years 2015 through 2020 across all vessel categories (Nuka Research and Planning and Pearson Consulting LLC 2015). Historical rates ranged 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). Eight large spills (≥ 1000 bbl) from vessels (tankers and, in one case, a tug) are documented in Cook Inlet between 1966 and 2015 (BOEM 2016). No large spills have occurred in the area in recent years (BOEM 2017).

On February 7, 2017, a Hilcorp helicopter flying between Nikiski and Platform A spotted bubbles from a natural gas leak in one of their pipelines. The gas leak was reported to the National Response Center and ADEC. Subsequent Hilcorp data revealed that the leak had been occurring since late December. The initial estimated leak rate was between 225,000 to 325,000 cubic feet per day from an eight-inch pipeline at a depth of 80 feet. The pipeline was originally installed in 1965, is 7 miles long, and initially carried crude oil before being converted over to natural gas. Leaks were repaired in another section of the line in 2014, a year before Hilcorp bought the asset.

On April 1, 2021, another leak from this same pipeline was reported. The leak was stopped on April 3, 2021, by activating block valves. PHMSA has ordered that the aging pipeline be replaced.

The Anna Platform experienced a diesel beam tank spill of 441 gallons on January 24, 2018. All the diesel was recovered and recycled. Hilcorp has also reported recent minor spills ($\leq$ 200 gallons) of drilling mud from the Steelhead and Granite Platforms and a glycol spill from the Bruce Platform, with most or all spilled material recovered[14].

The ADEC Statewide Oil Spills Database[14] provides public access to 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 it is often reported that they are contained and disposed of properly. Four spills have been recorded so far in 2021, twelve in 2020, and 18 in 2019. Because of all the oil and gas development and vessel traffic in and around Cook Inlet, spills appear 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.

5.5.2. Wastewater Discharge

Ten communities currently discharge treated municipal wastes into Cook Inlet. Wastewaters entering these plants may contain a variety of organic and inorganic pollutants, metals, nutrients, sediments, bacteria and viruses, and other emerging pollutants of concern. 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.

Primary treatment involves screening and sedimentation to remove solids and disinfecting the effluent. In general, this process removes 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 about 85 percent of remaining

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

organic matter. Tertiary treatment involves both primary and secondary treatment as well as additional processes to remove phosphates and nitrates (Sonune and Ghate 2004).

The Anchorage John M. Asplund Wastewater Treatment Facility (AWTF) is the largest wastewater facility in Alaska and is located in upper Cook Inlet, within the action area. AWTF provides primary treatment only and removes approximately 80 percent of solids prior to discharge[15]. The facility was built in 1972, upgraded in 1982 (28 million gallons per day [mgd]), and then upgraded again in 1989 (58 mgd). The EPA issues a waiver to AWTF for secondary treatment and allows the direct discharge of wastewater into Cook Inlet near Point Woronzof once the wastewater has undergone primary treatment (Figure 21.). The AWTF is allowed to discharge primary treated wastewater due to the levels of sediment they are able to extract and the extreme tides and currents of Cook Inlet[15]. Once the solids are 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).

Figure 20. Route of outfall pipe for the Anchorage John M. Asplund Wastewater Treatment Facility.

The Village of Tyonek wastewater treatment facility, located near the portion of Cook Inlet most heavily used by feeding Cook Inlet beluga whales, provides primary treatment to wastewater. Tyonek operates on a gravity fed sewer that drains into a community septic tank. Every spring and fall, the solids are transferred to a sludge lagoon for dewatering. The liquid effluent is then discharged into Cook Inlet.

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

There are other wastewater treatment facilities in Cook Inlet, including in Kenai[16]. The City of Kenai wastewater facility is one of the larger wastewater treatment facilities in Cook Inlet and is located near the largest runs of salmon in Cook Inlet. The Kenai wastewater treatment facility discharges secondary treated wastewater from its treatment plant directly into Cook Inlet, and the sludge is taken to the Soldotna landfill. The facility's design flow is 1.330 mgd with an average daily flow of 0.573 mgd. The City of Kenai began upgrades to the facility in 2018 and continues to upgrade their system[17].

Wastewater discharge from oil and gas development could 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 (EPA 2015; NMFS 2008a). Under the NPDES permit issued by EPA, oil and gas facilities are required to monitor the effluent for pollutants and meet standards specified in the permit before it is discharged into Cook Inlet (EPA 2015).

5.5.3. Mixing Zones

In 2010, EPA consulted with NMFS on the approval of ADEC's Mixing Zone Regulation section [18 AAC 70.240], including most recent revisions, of the Alaska Water Quality Standards [18 AAC 70; WQS] relative to the endangered Cook Inlet beluga whale (NMFS 2010). The 2010 biological opinion concluded that there was insufficient information to conclude whether belugas could be harmed by the elevated concentrations of substances present in mixing zones, but that the action was not likely to jeopardize the continued existence of the species. The 2010 opinion did not address the effects of the proposed action on Cook Inlet beluga whale habitat, which NMFS designated in 2011. 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.

5.5.4. Stormwater Runoff

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

Numerous releases of petroleum hydrocarbons have been documented from the POA, JBER, and the Alaska Railroad Corporation (ARRC). The POA transfers and stores petroleum oils, as well as other hazardous materials. 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).

[16] https://www.soldotna.org/departments/utilities/waste-water-treatment
[17] https://www.kenai.city/publicworks/page/water-sewer

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.

5.5.5. Aircraft De-icing

The Ted Stevens Anchorage Airport serves over 5 million passengers annually and is among the top 5 airports for cargo throughput. Operating throughout the year, deicing and anti-icing of aircraft and airfield surfaces are required by the Federal Aviation Administration. Deicing and anti-icing chemicals are used from October through May and may be used on aircraft, tarmacs, and runways. During the 2018-2019 reporting period airlines and ground service providers operating at the airport reported that they had applied 693,192 gallons of ADF to aircraft (99.9 percent propylene glycol and 0.1 percent ethylene glycol). Because one of the stormwater outfalls from the airport enters Knik Arm directly, deicing chemicals contribute pollutants to Cook Inlet.

Historically the primary airfield deicing ingredients were urea and potassium acetate (ADEC 2019). The Airport Authority continued to use pelletized urea until 2013, and now only potassium acetate is used for pavement deicing (ADEC 2019). In the first year of exclusively using potassium acetate, 1,390.5 tons were used. Switching to potassium acetate helped reduce nutrient discharges to receiving waters compared to the use of urea.

Snow removed from areas in contact with the deicing chemicals and other contaminants generally found around terminals is segregated and stored separately from snow removed from other areas on the airport property (e.g. streets, parking lots) (ADEC 2019). Snow disposal sites are selected for infiltration capacity and for the natural biodegradation of organic compounds that can occur prior to meltwater entering the storm water drainage system.

The Airport Authority began operating under the Environmental Protection Agency (EPA) Multi Sector General Permit (MSGP) industrial storm water general permit in December 1992. A Storm Water Pollution Prevention Plan (SWPPP) was prepared, as required by the permit, and certified in April 1993 (ADEC 2019). In October 2009, storm water permitting authority including the MSGP permit authority shifted from EPA to the Alaska Department of Environmental Conservation (DEC). DEC 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 prevalent and it was determined that the deicing chemicals were the cause. A Notice of Violation was recorded in all three years (ADEC 2019).

The current permit for the Ted Stevens Anchorage airport issued in 2020, requires monthly sampling and reporting of several water quality standards and an annual report for the outfall entering Knik Arm. When assessing impact to CI beluga whales the DEC determined that the waters near the outfall were used by belugas primarily as a transit corridor, to travel in and out of Knik Arm, and that their exposure to elevated levels of contaminants in April and May when the majority of runoff occurs would be extremely limited (ADEC 2019).

The Ted Stevens Anchorage International Airport and JBER airport are the largest airports in the Cook Inlet region. Other smaller airports exist throughout the Cook Inlet watershed, including Merrill Field, Lake Hood, and Lake Spenard (NMFS 2008a). Characterization of potential contamination from these facilities has not been done. It is likely that they all regularly contribute small amounts of pollutants to Cook Inlet through stormwater runoff.

5.5.6. 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 ranges from extirpation of native species through competition or predation, shifts in ecosystem food webs, to changes to the physical structure of the habitat (Norse and Crowder 2005). To address the issues related to the transport of invasive species 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 (NBIC). The NBIC has been receiving ballast water reporting forms from ships that arrive to U.S. ports from overseas since July 1, 1999. However, Robertson and Crews (2003) found from July 1, 1999 through December 31, 2001, reporting compliance at five Cook Inlet ports was only 35 percent. The regulations were new at the time and it is not known whether compliance has improved in the 20 years since.

In 2004 the US Coast Guard (USCG) established rules for controlling the discharge ballast water in U.S. waters, through publication of 33 CFR Part 151 and 46 CFR Part 162. 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 (BWTS),
- 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.

In addition, by law no discharges of any kind are allowed within three miles of land. Before the problems with ballast water were fully recognized and regulated it is likely untreated ballast water was released in Cook Inlet. The NBIC reported that more than five million metric tons of ballast water were released in Cook Inlet, from Homer to Anchorage, between 1999 and 2003.

Given the timeframe, it is likely this ballast water was untreated. 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 (one species – the cultured oyster – is not reproductive), and 7 species of vascular plants (Hines and Ruiz 2000). When compared to similar surveys from California to Washington, Ruiz et al. (2006) suggested that relatively few invasives are common in Alaska's coastal waters. Dueñas et al. (2018) conducted a systematic literature review of the available scientific evidence on invasive species' interactions with all threatened and endangered species protected under the ESA. They did not find any studies indicating that ESA-listed marine mammals negatively impacted by invasive species.

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

5.5.7. Contaminants Found in Listed Species

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

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

Polycyclic aromatic hydrocarbons (PAHs), a group of contaminants found in petroleum products, combined with other contaminants, may cause cancer in beluga whales (Kingsley 2002). High levels of PAHs have cytotoxic, genotoxic, immunotoxic, and carcinogenic effects on aquatic wildlife and are a concern with respect to the conservation and recovery of the Cook Inlet beluga whale. 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 from oil and gas exploration, development, or production activities. 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 but also from advection into the Inlet (Saupe et al. 2014.

Some of the ways that belugas can be exposed to PAHs are through inhalation, direct contact with oil slicks or dissolved plumes, direct contact with contaminated sediments, or by ingesting contaminated prey. Beluga whales spend a significant portion of their time in intertidal and nearshore areas, where the risk is often highest for exposure to PAHs given that it is in the nearshore environment where most point-source hydrocarbon discharges occur, where natural and anthropogenic PAHs from non-point-source run-off enter the marine environment, and where oil spills are most common and can be retained in the habitat (Saupe et al. 2014). Poirier et al. (2019) examined stained sections of intestines from belugas from St. Lawrence Estuary (SLE), Cook Inlet, the Arctic, and aquaria. The samples from SLE (where high levels of PAHs were discharged from aluminum smelters) and from Cook Inlet showed that SLE beluga and CI beluga had levels of intestinal PAH–DNA adducts significantly higher than Arctic and aquarium beluga ($P = 0.003$ and 0.02, respectively) (Poirier et al. 2019). A DNA adduct is a segment of DNA bound to a cancer-causing chemical. 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 liver CI beluga males, and in the blubber of females, and in two fetuses. Thus far, necropsies on CI beluga whales have not shown the high incidence of cancers that have been documented for the SLE belugas.

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

5.6. Fisheries

Cook Inlet supports several commercial fisheries, all of which require permits. The upper Cook Inlet commercial fishing region consists of 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 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).

In 2016, approximately 3.0 million salmon were harvested commercially in upper Cook Inlet, which is below the average annual harvest from 1966-2016 (3.5 million salmon; (Shields and Dupuis 2017)). Approximately 95.8 tons of eulachon (100 tons is the maximum allowable harvest) and 22.9 tons of herring were commercially harvested in 2016 (Shields and Dupuis 2017). The 2020 Upper Cook Inlet commercial harvest of approximately 1.2 million salmon was 65 percent less than the recent 10-year average harvest of 3.2 million fish and sockeye salmon returns were approximately 73 percent less than the 2010-2019 average annual harvest (Brenner et al. 2021). The 2020 upper Cook Inlet commercial harvest of all Chinook salmon stocks was 3,008 fish, which was 56 percent less than the previous 10-year average (2010–2019) annual harvest of 6,848 fish, and the second lowest harvest on record (Brenner et al. 2021). 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. However, because salmon are the primary prey item for Cook Inlet beluga whale, 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.

At the Kenai River sonar, the peak day of sockeye salmon passage occurred on August 17, 2020, with a count of 134,874 fish. This was the highest daily sockeye salmon passage ever recorded in August at the Kenai River sonar, and the latest peak of sockeye salmon movement recorded (Brenner et al. 2021). During the previous 10 years, the average date where 50 percent of the yearly sonar passage occurred in the Kenai River was July 25. In 2020, 50 percent of the total passage did not occur until August 6 and approximately 61 percent of the run arrived in August (Brenner et al. 2021). The cause of this delay in returns is not known.

Recreational fisheries exist in the river systems on the western Kenai Peninsula for salmon (king, silver, red, and pink), both freshwater and marine Dolly Varden char, and both freshwater rainbow trout and steelhead trout. In the marine waters throughout Cook Inlet, recreational fishing occurs for salmon (king and silver), 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 was begun in 2020 on the Susitna River from July 10 to July 31 on Wednesdays and Saturdays for all species other than king salmon.

NMFS assumes that ADFG will continue to manage fish stocks and monitor and regulate fishing in Cook Inlet to maintain sustainable stocks. We do not know the extent to which salmon and eulachon may be less available to Cook Inlet belugas due to removals by commercial, subsistence, personal use, and sport fishing or by human-caused habitat avoidance. Gathering pertinent data near the mouths of salmon and eulachon spawning streams is especially important.

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[18], and historically was also important foraging habitat for Cook Inlet beluga whales (e.g., waters within and near the outlets of the Kenai and Kasilof Rivers during salmon season) (Ovitz 2019). Belugas no longer use waters near the Kenai River during salmon fishing season despite the very large salmon returns there, and despite their historic use of these runs.

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

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

Humpback whales can be killed or injured during interactions with commercial fishing gear, although the evidence available suggests that the frequency of these interactions may not have significant adverse consequence for humpback whale populations (Muto et al. 2020). Most humpbacks in Alaska get entangled with gear between the beginning of June and the beginning of September, when they are on their nearshore foraging grounds. Between 1990 and 2016, 29 percent of humpback entanglements were with pot gear, 37 percent were with gillnet gear and 1-2 percent were with longline gear.

A photographic study of humpback whales in southeastern Alaska in 2003 and 2004 found at least 53 percent of individuals showed some kind of scarring from fishing gear entanglement (Neilson et al. 2005). During 2010-2014, mortality and serious injury of humpback whales occurred in the Bering Sea/Aleutian Islands pollock trawl fishery (1 each in 2010 and 2012) and the Bering Sea/Aleutian Islands flatfish trawl fishery (1 in 2010). The estimated average annual mortality and serious injury rate from observed U.S. commercial fisheries is 0.6 Western North Pacific DPS humpback whales in 2010-2014 (Muto et al. 2020). 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).

Overall, the estimated mean annual mortality and serious injury rate from U.S. commercial fisheries is 31 western DPS Steller sea lions per year, which is likely an underestimate of the actual level (Muto et al. 2020). Of these, 16 are taken in federally managed commercial fisheries. Results from a study conducted in the Aleutian Islands during June and July 1985, found that a very low percentage of observed sea lions entangled in discarded fishing net or twine, and a second study conducted during November 1986 found no entangled pups and only one entangled juvenile out of a total of 3,847 sea lions examined (NMFS 2008b). Juveniles are likely to be most vulnerable to entanglement in marine debris. Overall, the relative impact on the recovery of the western DPS of Steller sea lion due to entanglement in marine debris is ranked as low (NMFS 2008b).

Approximately 400 observations of Steller sea lion entanglements and fishery gear interactions, many of which were repeat sightings, were documented and reviewed by ADF&G based on standardized annual summer surveys conducted at nearly every sea lion haulout and rookery in Southeast Alaska, Prince William Sound, the Barren Islands, and Bristol Bay from 2013-2017 (Delean et al. 2020). From these observations, 228 incidents of seriously injured Steller sea lions were determined to be unique animals. Among these records, hooking and/or ingestion of fishing gear (n = 114) and entanglement/entrapment in fishing gear and marine debris (n = 107) were most prevalent; the remainder (n = 7) were dependent pups with seriously injured mothers (Delean et al. 2020). No incidents were documented in Cook Inlet during this time where both observation effort and sea lion density are low.

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

5.6.2. Competition for Prey

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

There is strong indication that Cook Inlet beluga whales are dependent on access to relatively dense concentrations of high value prey species, particularly in the spring and throughout the summer months. Norman (2011) estimated that the total biomass of fish consumed by 350 Cook Inlet beluga whales during the summer would be approximately 1250 metric tons. Chum, coho, and other salmonid species constitute >54 percent of the Cook Inlet beluga whales' summer diet (Hobbs and Shelden 2008). As discussed in the introduction to this section, the 2020 Upper Cook Inlet commercial harvest of all salmon was 65 percent less than the recent 10-year average and sockeye salmon returns were approximately 73 percent less than the 2010-2019 average annual harvest (Brenner et al. 2021). A reduction in the amount of available prey could impact the energetics for Cook Inlet beluga whales and delay recovery.

Whether fisheries reduce Steller sea lion prey biomass and quality at local and/or regional spatial scales, leading to a reduction in Steller sea lion survival and reproduction, has been a matter of considerable debate among the scientific community (NMFS 2008b). The most recent minimum total annual (direct) mortality of Western DPS Steller sea lions associated with commercial fisheries is 31 individuals (Muto et al. 2020).

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). That is the only known incident of interactions of humpback whales and fisheries in Cook Inlet. Prey competition is unlikely to occur, as the important foraging areas for humpback whales are outside of Cook Inlet.

5.7. Direct Mortality

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

5.7.1. Subsistence Harvest

The ESA and MMPA allow for the harvest of marine mammals by Alaska Natives for subsistence purposes and for traditional handicrafts. Subsistence hunters in Alaska are not authorized to take humpback whales (Muto et al. 2020). However, one humpback whale was illegally harvested in Kotlik in October, 2006, and another was illegally harvested in Toksook Bay in May, 2016.

Annual statewide data on community subsistence harvest of Steller sea lions are no longer collected as of 2009. The mean annual subsistence take (harvested plus struck-and-lost) from the Western DPS from 2004 through 2008, combined with the mean annual take between 2011-2015 from St. Paul and St. George, is 204 sea lions per year (Muto et al. 2020). Subsistence harvest of Western DPS Steller sea lions occurs under co-management agreements with NMFS, and occurs at or well below sustainable levels of harvest.

The effect from past subsistence harvests on the Cook Inlet beluga whale population was significant. While an unknown amount of harvest occurred for decades or longer, the subsistence harvest levels increased substantially in the 1980s and 1990s to unsustainable levels. Reported subsistence harvests during 1994-1998 probably account for the stock's decline during that interval. In 1999, beluga whale subsistence harvest discontinued as a result of both a voluntary moratorium by the hunters that spring, and Public Law 106-553 section 627, which required hunting of Cook Inlet beluga whale for subsistence uses be conducted pursuant to a cooperative agreement between NMFS and affected Alaska Native organizations. In 2005, a co-management agreement allowed the harvest of two whales. In 2006, the co-management agreement allowed the harvest of one whale, however no whales were taken due to poor weather, and hunters' avoidance of females with calves.

In 2008, NMFS issued regulations (73 FR 60976; October 15, 2008) 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.

5.7.2. Poaching and Illegal Harassment

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

Poaching and illegal harvest of Steller sea lions has historically occurred throughout their range. The NMFS Alaska Marine Mammal Stranding Program documented 60 Steller sea lions with suspected or confirmed firearm injuries from 2000–2019 in Southeast and Southcentral Alaska (Wright and Savage 2016; Wright and Savage 2021). Western DPS Steller sea lions with suspected gunshot wounds have been found stranded on shore along the outer Copper River Delta as recently as 2019 (Wright and Savage 2016; Wright and Savage 2021). Investigations led to guilty pleas and convictions of two men for illegally shooting the sea lions[19]. It was determined that seven of nine pinnipeds stranded in the surveyed area in 2019 were intentionally killed (Wright and Savage 2021).

Few illegal harvests of humpback whales have occurred in Alaska (only 2 cases are known), and those that have occurred resulted primarily from the misperception by subsistence hunters in western Alaska that they were authorized to harvest large whales other than bowheads (e.g., humpback, gray, and minke whales).

5.7.3. Stranding

Cook Inlet beluga whales may be predisposed to stranding because they breed, feed, and molt in the shallow waters of upper Cook Inlet where extreme tidal fluctuations occur. However, stranding events that last more than a few hours may result in mortalities. Strandings can occur when belugas attempt to avoid killer whale predation, when they chase prey into shallows and then become trapped by the receding tide, or as a result of injury or illness. From 1988 through 2015 an estimated 876-953 Cook Inlet beluga strandings led to 22 mortalities (NMFS 2016b). Over that same time frame, 214 floating or beached dead belugas were recorded in Cook Inlet (NMFS 2016b). In 2003, an unusually high number of beluga live stranding events (5) occurred in Turnagain Arm (Vos and Shelden 2005). The number of animals stranded ranged from 2 to 46 and led to 5 confirmed deaths (Vos and Shelden 2005). Because beluga groups can contain over 100 individuals, large stranding events involving over 50 individuals have been recorded several times (Vos and Shelden 2005). Even though deaths at the stranding site are recorded infrequently, stranding is a stressful event and may affect beluga health after the event. Stranding

[19] https://www.justice.gov/usao-ak/pr/two-alaska-men-charged-harassing-killing-steller-sea-lions-and-obstructing-investigation

events may represent a significant threat to the conservation and recovery of this stock. In a summary of patterns of mortality, McGuire et al. (2020a) found that live stranding was the predominant assigned cause of death but represented only ~33 percent of deaths of known cause. Causal factors for the majority of deaths and live strandings are unknown.

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

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

5.7.4. Predation

Killer whales are the only natural predators for beluga whales and Steller sea lions in Cook Inlet (Muto et al. 2020). Interviews with people who have fished the upper Inlet for 20 to 50 years reported few sightings of killer whales (Shelden et al. 2003). In his study of TEK, Huntington (2000) interviewed Alaska Native beluga hunters who reported that killer whales were rarely seen in the upper Inlet or near belugas. 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 (McGuire et al. 2020) nor in Knik Arm by marine mammal observers on watch during construction activities at the POA in 2020 or thus far in 2021. In addition, photographs taken of beluga whales over 13 consecutive field seasons (2005–17) in Cook Inlet did not record any with scars consistent with killer whale attacks (McGuire et al. 2020b).

However, between June 2009 and May 2010, acoustic recorders detected killer whales 17 times. Most detections were in lower Cook Inlet near Homer Spit, with a single detection at the Tuxedni Bay and Beluga River locations in upper Cook Inlet. Castellote et al. (2016b) had no acoustic detections of beluga whales near Homer Spit from 2008-2013. Of the 17 killer whale detections between 2009-2010, only the one recorded near the Beluga River in upper Cook Inlet was likely from a transient killer whale, which has an acoustic behavior very different and distinguishable from resident killer whales (Barrett-Lennard et al. 1995; Castellote et al. 2016b). The killer whale detection was near Beluga River and was concurrent with the presence of belugas but there is no record of attacks on belugas that year. Transient killer whales prey on marine mammals whereas resident killer whales focus primarily on salmon (Barrett-Lennard et al. 1995).

Matkin (2011), in a study of killer whales in lower Cook Inlet in July of 2008, had four encounters with transients (marine mammal-eating) and six encounters with resident (fish-eating) whales. In 2009 all killer whale encounters were with resident killer whales. Two attacks were observed by the transients, one on a humpback whale which was unsuccessful and one on a sea otter. They had no sightings of beluga whales during their surveys in lower Cook Inlet. They noted that transient killer whales tend to use areas where prey is abundant. Because beluga whales are far less abundant than they once were and are concentrated in the upper Inlet which has hazardous conditions for killer whales, the likelihood of killer whale predation is reduced (Matkin 2011).

From 1982-2008, 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 killer whale sightings in upper Cook Inlet or possible predation attempts. 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 2001-2012 only three Cook Inlet beluga whales were reported as preyed upon by killer whales but for one of those deaths killer whale was a possible cause of death; the body condition was too poor to make a positive determination (NMFS 2016b). These results could be an underestimate as the remains of preyed-upon belugas may sink and go undetected by humans.

Killer whale predation has been reported to have a potentially significant impact on the Cook Inlet beluga whale population (Shelden et al. 2003). However, the very low number of sightings or acoustical detections in the upper Inlet over the last 20 years indicates that the threat from killer whale predation may be less than initially hypothesized or may have been greater when the beluga population was more robust. The contraction in Cook Inlet beluga summer range to the shallow waters of the upper Inlet may also reduce the opportunity for killer whales to pursue belugas in this area (NMFS 2016)

The risk to Western DPS Steller sea lions from killer whale predation is considered potentially high (Muto et al. 2020), and may be one of the causes contributing to population declines in areas outside of Cook Inlet (Barrett-Lennard et al. 1995). As noted above, an unsuccessful killer whale attack on a humpback whale was recorded in 2008 in lower Cook Inlet. Because the numbers of Steller sea lions and humpback whales are very low in Cook Inlet any isolated predation event that may occur would not have a population level effect.

5.7.5. 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 (McGuire et al. 2020b). Fourteen percent had signs of confirmed or possible vessel strike. A death in October 2007 was attributed to a potential vessel strike based on bruising consistent with blunt force injuries (NMFS unpublished data) and in October 2012, a necropsy of another Cook Inlet beluga carcass indicated the most likely cause of death was "blunt trauma such as would occur with a strike with the hull of the boat" (NMFS AKR, unpub. data).

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 et al. 2014), suggesting that small vessel strikes are not rare, but such strikes are often survivable. Small boats are able to quickly approach and disturb these whales in their preferred shallow coastal habitat. 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 was found in Kachemak Bay that may have been hit by a boat. The Steller sea lion had two separate wounds consistent with blunt trauma (NMFS Alaska Regional Office Stranding Database accessed May 2019). Because of their maneuverability, the very low number of Steller sea lions in upper Cook Inlet, and the slow vessel speeds in and around the POA, a vessel striking a Steller sea lion is highly unlikely to occur.

From 1978-2012, there were at least 108 recorded whale-vessel collisions in Alaska, with the majority occurring in Southeast Alaska (Neilson et al. 2012). Delean et al. (2020), examining data from 2013-2017, found that 29 humpback whales were struck resulting in 11.92 mortalities or serious injuries in Alaska and the U.S. West Coast. Among larger whales, humpback whales are the most frequent victims of ship strikes in Alaska, accounting for 86 percent of all reported collisions. There have been five documented large cetacean vessel collisions in Cook Inlet since 2001; one humpback whale, one fin whale, two beluga whales, and one unidentified large cetacean. In 2001, a humpback whale was discovered on the bulbous bow of a 710 ft container ship as it docked in the Port of Anchorage. It is unknown where the vessel may have collided with the whale. The very low number of humpback whales in upper Cook Inlet greatly reduce the probability of vessel strike in this area.

5.7.6. Research

Research is a necessary endeavor to assist in the recovery of threatened and endangered species; however, research activities can also disturb, harm and kill these animals. Research on marine mammals often requires boats, adding to the vessel traffic, noise, and pollution near the action area. Aerial surveys can also disturb whales, especially when circling at low altitudes to obtain accurate group counts. Boat based surveys, such as photo-identification studies, often require the boat to closely approach whales or whale groups. Deployment and retrieval of passive acoustic monitoring devices requires a boat, which temporarily increases noise in the immediate area. However, once the instruments are deployed, passive acoustic monitoring is noninvasive.

Research activities can be more invasive, especially when they include animal capture, collecting blood and tissue samples, or attaching tracking devices such as satellite tags. Between 1999 and 2002, NMFS placed satellite tags on 18 beluga whales in upper Cook Inlet (Hobbs et al. 2005). Shortly after a tagging event in 2002, a tagged beluga whale was found dead; its tag had transmitted for only 32 hours. Another two tagged beluga whales transmitted data for less than 48 hours, with similar dive patterns; it is unknown whether these whales, tagged in the same manner as the one that died, also perished, or were fitted with defective tags (NMFS, unpublished data). In 2015, a previously tagged beluga was found stranded with significant infection at the instrument attachment site. Infection was implicated as a possible cause of death. Similarly, another whale photographed through 2006 with serious infection at the tag site has not been photographed since 2007 (McGuire and Stephens 2016b).

The photo identification project begun in 2005 was able to identify many of the beluga whales that had been tagged in the 1999-2002 tagging projects (McGuire and Stephens 2016b). At the time that they reported on data collected through 2015, five of the 14 confirmed satellite tagged whales in the photo-id catalog had visible signs of tag-site infection, and eight had signs of concavity of the dorsal crest above the tag site. Two whales showed damage to the left pectoral fins likely caused by flipper bands applied during tagging (McGuire and Stephens 2016b).

The satellite tags were able to provide data on the movement within Cook Inlet and dive behavior (Shelden et al. 2018). However, of the 18 tags deployed on belugas in the summer only 4 provided data into spring.[20] Given the consequences of the tagging project and the status of the beluga population it is unlikely that this type of project will be repeated. It is expected that research will continue but will focus on minimally invasive research techniques.

Steller sea lions and humpback whales are more likely to be found in lower Cook Inlet, and as such, research on these species is focused in the lower inlet. Aerial surveys have the potential to affect Steller sea lions, primarily due to aircraft noise-induced harassment that can cause sea lions to flee haulouts or rookeries, potentially resulting in the crushing of pups and young animals. Such events can occur after an aircraft has already passed by the animals. However, no rookeries or haulouts where Steller sea lions are concentrated occur within Cook Inlet. There are no known instances of research-related deaths of humpback whales in Cook Inlet.

5.8. Climate and Environmental Change

Climate change can cause direct effects to listed species as well as changes in human activities that result in indirect effects. For example, less ice could lead to increased vessel activity with an associated increase in noise, pollution, and risk of ship strike.

Changes in prey availability to belugas may result from changes in the total availability, quality, species composition, and seasonality of prey. While the potential exists for human fishing pressure to change the abundance, seasonality, or composition of beluga whale prey, 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 beluga feeding areas for efficient foraging by belugas (NMFS 2016).

Specific to Cook Inlet beluga whales, 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 as discussed in section 4.2 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). Consequently, fish are

[20] https://archive.fisheries.noaa.gov/afsc/News/Cook_Inlet_Beluga_Range_Contracted.htm

particularly vulnerable to mortality during periods of increased water temperatures. High water temperatures may cause mortality 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). October 2019 to September 2020 represented the second warmest 12-month period of observed surface air temperatures over the Arctic land during the last century (Ballinger et al. 2020). This continued the current pattern of 7 consecutive years (and 9 of the last 10 years) where the surface air temperature anomalies were at least 1ºC warmer than the 1981-2010 mean (Ballinger et al. 2020). June and especially July 2019 set air temperature records over much of Alaska and the southern Yukon Territory[21].

These warm air temperatures translated into warm stream temperatures in July 2019 across Alaska. Reports of salmon dying before they could spawn were recorded in the Yukon River (von Biela et al. 2020), the Koyukuk (Westley 2020), the Igushik River, a tributary to Bristol Bay where it was estimated that a minimum of 100,000 salmon died,[22] and the Kuskokwim.[23] The parasites *Ichthyophonus* (a protozoan) and *Henneguya* (a cnidarian) which cause tapioca disease were prevalent in the salmon from the Kuskokwim. Prespawning mortality has also been documented recently in several Pacific Northwest watersheds, including the Fraser River in British Columbia (Hinch et al. 2012; Martins et al. 2012) and streams in the Lake Washington Basin (Washington)(Barnett et al. 2020). Barnett et al. (2020) concluded that warming conditions during migration and spawning, in concert with other factors such as infections with pathogens, were responsible for the increased prespawning mortality of adult sockeye salmon high enough to threaten the population's viability.

Mauger et al. (2017) monitored stream temperature during open-water periods from 2008 to 2012 in 48 nonglacial streams across the Cook Inlet basin. They found that numerous nonglacial watersheds in the Cook Inlet region had stream temperatures that exceeded threshold maximum weekly maximum temperature (MWMT) ranges identified by the US Environmental Protection Agency (US EPA) for the protection of salmon life stages. These criteria, above which chronic and sublethal effects become likely, are 13 °C for spawning and egg incubation, 16–18 °C for juvenile rearing, and 18–20 °C for adult migration (US EPA 2003). Even in their relatively cool sampling period, MWMT at most sites exceeded the established criterion for spawning and incubation during every year of the study, which suggests salmon in some streams are already experiencing thermal stress in the Cook Inlet region (Mauger et al. 2017). Of note is that the Deshka River had MWMT temperatures above 20°C in 3 of the 5 years of study and over 18°C in 4 years (Mauger et al. 2017). The Deshka River is an important tributary to the Susitna River. As stream temperatures gradually increase in response to increasing air temperatures, critical thresholds will likely be exceeded more often, especially when warm air temperature anomalies occur.

[21] https://www.ncei.noaa.gov/news/national-climate-201912
[22] https://www.alaskapublic.org/2020/01/15/in-some-bristol-bay-rivers-the-hottest-month-on-record-was-deadly-for-salmon/
[23] https://www.kyuk.org/post/record-warm-water-likely-gave-kuskokwim-salmon-heart-attacks

Thermal regimes in freshwater ecosystems will change as air temperatures increase regionally. As air temperatures increase, the distribution and intensity of precipitation will change which will in turn alter freshwater hydrology (Bryant 2009; Shanley and Albert 2014). Shifts in the amount, intensity, and form (more rain vs. snow) of precipitation are anticipated to alter the hydrological regimes of streams in southeast Alaska (Shanley and Albert 2014). In the future, predicted hydrologic change associated with climate change may be the biggest challenge to Pacific salmon conservation and management (Shanley and Albert 2014). In examining the decline of two Chinook populations in Alaska (Chena and Salcha rivers), Neuswanger et al. (2015) found that low productivity was strongly associated with high stream discharge during the summer of freshwater residency for young-of-the-year Chinook salmon. The association was more consistent with the hypothesis that sustained high discharge negatively affected foraging conditions than with acute mortality during floods. Productivity may have also been reduced in years when incubating eggs experienced major floods or cold summers and falls (Neuswanger et al. 2015).

An additional challenge to salmon production in Cook Inlet is exemplified by Alexander Creek and the Deshka River, tributaries to the Susitna River. Pike were illegally introduced to the Susitna River basin in the 1950s and occupy both streams (Sepulveda et al. 2015). Some of the worst declines in salmon populations from pike predation have occurred in Alexander Creek (Dunker et al. 2020). Sepulveda et al. (2015) found that salmonids constitute the major prey items for pike in the Deshka River and in the lower reach of Alexander Creek throughout the summer. They estimated that pike in Alexander Creek could consume 193,000–553,000 juvenile salmon each summer. These consumption estimates equal 45–100 percent of the Chinook salmon smolts produced by returning adults prior to their decline in 1999 (Sepulveda et al. 2015). Efforts are being made to keep the pike numbers in check through suppression (annual gillnetting) and eradication through the use of piscicides (Dunker et al. 2020). The Alaska Department of Fish and Game has written a management plan for controlling pike (ADFG 2007). Over half of the Susitna River Basin contains suitable habitat for pike and these streams are also important rearing habitats for juvenile salmon, especially chinook and sockeye which spend one, or one to four years in freshwater, respectively, before emigrating to salt water. Warmer water temperatures would favor pike in these streams.

Population modeling done by Norman et al. (2020) suggests that reproductive success in Cook Inlet beluga whales is tied to salmon abundance in the Deshka River. The mechanism model with the best fit was the sum of Chinook and coho in the year of beluga birth and year prior to birth. 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. They suggest that the population is likely dependent on the Chinook run, and to a lesser degree, the coho run, because coho have less than one-quarter of the energy content of the Chinook (Norman et al. 2020). Although this analysis is informative, given that Cook Inlet beluga whales forage at several streams throughout the summer it is seems that they may be more dependent on the portfolio effect as first described for the Bristol Bay watershed (Schindler et al. 2010) but which applies to other ecosystems as well (Schindler et al. 2015). The concept is that aggregate systems are often less volatile than their components (Schindler et al. 2015). Individual streams may not have good returns on a given year but because of the size of the watershed and the physical and biological variability among the streams, the end result is a stable production of salmon. For the Cook Inlet beluga whales, most likely they are not totally dependent on production of one species in one stream within the Susitna watershed or only on the Susitna watershed but rely on the combined escapement from multiple watersheds. The results from Castellote et al. (2020) on foraging locations supports this idea. However, the concept that food resources may be limiting a cetacean population is not new as reduced prey availability (Chinook salmon) has been directly linked to increased mortality and reduced health and survival of the Southern Resident killer whale (Ward et al. 2009; Wasser et al. 2017).

In summary, the effects of climate change will likely create several challenges to Cook Inlet beluga whales, primarily through impacts to their primary prey species, salmon. Warmer ocean temperatures, warmer stream temperatures, and warmer air temperatures will likely create 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.

Whether recent increases in the presence of humpback whales in Cook Inlet can be attributed to climate change, whale population growth, and/or other factors remains speculative. There is no clear trend in the number of humpback whale sightings in lower Cook Inlet between 2004 and 2016 (Figure 15). Climate-driven changes in glacial melt are presumed to have profound effects on seasonal streamflow within the Cook Inlet drainage basin, affecting both anadromous fish survival and reproduction in unpredictable ways. Changes in glacial outwash will also likely affect the chemical and physical characteristics of Cook Inlet's estuarine waters, possibly changing the levels of turbidity in the inlet. Whether such a change disproportionately benefits marine mammals, their prey, or their predators is unknown.

An Unusual Mortality Event (UME) of large cetaceans occurred in Alaskan waters in 2015-2016. Reports of dead whales included 22 dead humpback, 12 fin, 2 gray, 1 sperm, and 6 unidentified whales. The fin whales were observed stranded within a 27-day period around Kodiak Island. This was concurrent with an unusually large number of dead whales found in British Columbia, which included 6 humpback, 5 fin, and 1 sperm whale (NMFS unpublished data). The strandings were concurrent with the arrival of the Pacific marine heatwave. The mortalities were also concurrent with one of the strongest El Niño 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. While we cannot say with certainty that this UME was caused or exacerbated by climate change, it remains a reasonable hypothesis.

Another UME was declared for gray whales along the west coast of North America in 2019[24], with 48 whales stranding in Alaska (including one in Cook Inlet) out of a total of 235 across their migration route from Mexico to Alaska. While the cause of the UME is undetermined at this time, preliminary findings in several of the whales have shown evidence of emaciation.

[24] https://www.fisheries.noaa.gov/national/marine-life-distress/2019-gray-whale-unusual-mortality-event-along-west-coast

However, these findings are not consistent across all of the whales examined, so more research is needed.

Cook Inlet beluga whale critical habitat may be affected by climate change and other large-scale environmental phenomena including 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 2010; NMFS 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 (Anderson and Piatt 1999; Hare and Mantua 2000; Hollowed and Wooster 1992) 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.

5.9. Natural Catastrophic Changes

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

5.10. Summary of Baseline Stress Regime in the Action Area

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

- Coastal development, particularly at the Port of Alaska, has resulted in exposure of beluga whales to noise levels capable of causing harassment.
- Oil and gas development (Figure 16 and Figure 18) has resulted in 79 spills releasing 126,259 gallons of oil into Cook Inlet since 1962.
- Seismic exploration has introduced anthropogenic noise into the marine environment of Cook Inlet, creating zones with a radius of 9.5 km in which sound was sufficiently loud to cause harassment. Seismic exploration has resulted in harmful Level A noise exposure to both humpback and beluga whales. It has also resulted in the temporary degradation of Cook Inlet beluga whale critical habitat.
- Aircraft have been observed to cause behavioral changes to groups of feeding beluga whales when the aircraft flew past at low altitudes or circled the groups.

- Fisheries that co-occur with concentrations of beluga prey may be competing with the whales for their prey. Beluga whales no longer avail themselves of abundant but heavily human-exploited salmon runs in the Kenai River during summer as they once did.
- Propeller scars observed on belugas may have resulted from collisions with recreational or commercial fishing boats.
- Subsistence whaling for Cook Inlet beluga whales by Alaska Natives represents the largest known anthropogenic mortality for the stock. While the population appeared to be increasing until 2010, there appears to have been a steeper decline after 2010 than was previously thought, currently estimated at -2.3 percent/year.
- Subsistence harvest of Western DPS Steller sea lions occurs under co-management agreements with NMFS, and occurs at or well below sustainable levels of harvest.
- Vessel traffic in Cook Inlet (Figure 20) poses varying levels of threat to the species depending on the type and intensity of the shipping activity and its degree of spatial and temporal overlap with habitats.
- Whether contaminants have resulted in the degradation of Cook Inlet beluga whale critical habitat remains unknown. Contaminant loads in Cook Inlet beluga whales are low compared to beluga whales in the Arctic and St. Lawrence Estuary.
- Wastewater is discharged into Cook Inlet, much of it untreated or undergoing only primary treatment. Effects of this discharge on marine mammals remain unknown.
- At least three Cook Inlet beluga whales died shortly after attachment of satellite transmitters to their backs in the early 2000s, another died in 2015, and another has not been photographed since 2007. No recent mortalities incidental to marine mammal research activities in the action area have been documented.
- There are insufficient data to make reliable estimations of the impact of climate change on marine mammals considered in this biological opinion. Although the effects of climate change and other large scale environmental phenomena on Cook Inlet beluga whale critical habitat cannot be predicted with certainty, impacts to their prey from oceanic regime shifts, or changes in freshwater habitat (hydrologic changes, increased water temperature) are projected to occur.
- The beluga whale has undergone notable summer range contraction in recent years, and whales now occur predominantly in upper Cook Inlet (Figure 8 and Figure 9).

The Cook Inlet beluga population continues to decline for unknown reasons, the population trend of Western North Pacific DPS of humpback whales is unknown, and Mexico DPS humpback whale population is likely declining. In contrast, Western DPS Steller sea lions within Cook Inlet 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, gender 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*,[25] 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 Western North Pacific DPS and Mexico DPS humpback whales is thought to be entanglement in fishing gear and vessel strike due to increased shipping throughout their range (Muto et al. 2020). These threats 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., noise, habitat loss or degradation, pollution).

[25] 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.

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 gives the benefit of the doubt to the listed species by minimizing the likelihood of false negative conclusions (concluding that adverse effects are not likely when such effects are, in fact, likely to occur).

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

We conclude this section with an Integration and Synthesis of Effects that integrates information presented in the Status of the Species (4.3) and Environmental Baseline (5) sections of this opinion with the results of our exposure and response analyses to estimate the probable risks the proposed action poses to endangered and threatened species and designated critical habitat.

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 factor 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 SFD project may result in the following stressors to ESA-listed marine mammals and their designated critical habitat:

- Acoustic disturbance from pile driving activities;
- Vessel noise, presence, and strike
- Pile Driving Noise and Prey
- Sea floor disturbance and turbidity
- Trash and debris; and
- Pollution and contaminants

6.2. Exposure and Response Analysis

As discussed in the Approach to the Assessment section of this opinion, exposure analyses are designed to identify the listed species and designated critical habitats that are likely to co-occur with these effects in space and time and the nature of that co-occurrence. In this step of our analysis, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent. For 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 Mitigation Measures section, the proposed mitigation measures should avoid or minimize exposure of Cook Inlet beluga whales, humpback whales, and Steller sea lions to stressors. Refer to Section 2.1.2 for details on the proposed mitigation measures.

Following the exposure analysis is the response analysis. The response analyses determine how listed species and 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.

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

- Threshold shifts
- Auditory interference (masking)
- Behavioral responses including avoidance of portions of affected habitat
- Non-auditory physical or physiological effects

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

6.2.1. Threshold Shift

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

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

6.2.2. Masking

The concept of acoustic interference is familiar to anyone who has tried to have a conversation in a noisy restaurant or at a rock concert. In such situations, the collective noise from many sources can interfere with one's ability to understand, recognize, or even detect sounds of interest. Masking from anthropogenic noise sources may disrupt marine mammal communication when sound frequencies overlap with communication frequencies used by marine mammals. Studies have shown that cetaceans' response may be similar to that of humans speaking louder to communicate in a noisy situation.

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

Vocal changes in response to anthropogenic noise can occur across sounds produced by marine mammals, such as whistling, echolocation click production, calling, and singing. Changes to vocal behavior and call structure may result from a need to compensate for an increase in background noise. In cetaceans, vocalization changes have been reported from exposure to anthropogenic noise sources such as sonar, vessel noise, and seismic surveying. Vocalizations may also change in response to variation in the natural acoustic environment (e.g., from variation in sea surface motion (Dunlop et al. 2014)). Holt et al. (2009) found that Southern Resident killer whales in Puget Sound near Seattle increased their call amplitude by 1 dB for every 1 dB increase in background noise levels.

Additionally, as anthropogenic sound increases in intensity, animals (including whales) are less able to compensate, and may cease auditory communication altogether. Kendall et al. (2014) found that beluga whales temporarily ceased vocalizing while travelling past the Port of Alaska during in-water construction activities.

The SFD project may result in masking while pile driving is occurring. Pile driving will occur over a relatively short time frame (maximum 24 days), most likely in August and/or September, in daylight hours only. During this work timeframe, pile driving will occur intermittently for a maximum of 21 hours total. Therefore, pile driving will not result in extended periods of time where masking could occur. As stated above, masking only exists for the duration of time that the masking sound is emitted.

6.2.3. Behavioral Response

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

- Modifying or stopping vocalizations,
- Changing from one behavioral state to another, and/or
- Avoidance or movement out of feeding, breeding, or migratory areas.

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

Except for some vocalization changes that may be compensating for auditory masking, all behavioral reactions are assumed to occur due to a preceding stress or cueing response, however, stress responses cannot be predicted directly due to a lack of scientific data (see 6.2.4 Non-Auditory Physical or Physiological Effects section). Responses can overlap; for example, an increased respiration rate is likely to be coupled with a flight response. Differential responses are expected among and within species since hearing ranges vary across species and individuals, the behavioral ecology of individual species is unlikely to completely overlap, and individuals of the same species may react differently to the same, or similar, stressor.

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

6.2.4. Non-Auditory Physical or Physiological Effects

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

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

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

Whales and Steller sea lions use hearing as a primary way to gather information about their environment and for communication; therefore, we assume that limiting these abilities is stressful. Stress responses may also occur at levels lower than those required for TTS (NMFS

2018a). Therefore, exposure to levels sufficient to trigger onset of PTS or TTS are expected to be accompanied by physiological stress responses (NRC 2003).

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

6.3. Major Acoustic Stressors[26]

As discussed in Section 2, Description of the Proposed Action and Action Area, the USACE intends to authorize pile driving activities within the action area, and NMFS Permits Division intends to authorize harassment of marine mammals incidental to this work.

6.3.1. Exposure Estimates

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

6.3.2. 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 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). 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,[27] expressed in root mean square[28] (rms), from broadband sounds that cause behavioral disturbance, and referred to as Level B harassment under section 3(18)(A)(ii) of the Marine Mammal Protection Act (MMPA) (16 U.S.C § 1362(18)(A)(ii)):

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

[26] Stressors that may affect, but are not likely to adversely affect, designated critical habitat for Cook Inlet beluga whales are discussed in Section 4.1.

[27] 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 (SPL) 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.

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

However, ambient noise levels within Knik Arm are above the 120-dB threshold, and therefore, for purposes of this analysis, NMFS considers received levels above those of the measured ambient noise (122.2 dB) to constitute Level B harassment of marine mammals incidental to continuous noise, including vibratory pile driving (non-impulsive sound). Note that in considering the radius to the sound isopleth at which project acoustic effects are assumed to no longer exist, 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). NMFS does not consider background sounds, including routine anthropogenic sounds, in the calculation of the area affected by project sound.

Results from the most recent acoustic monitoring conducted at the Port are presented in Austin et al. (2016) and Denes and Austin (2016) wherein sound levels were measured in absence of pile driving from May 27 through May 30, 2016 at two locations: "Ambient-Dock" and "Ambient-Offshore". NMFS considers the median sound levels to be most appropriate when considering background noise levels for purposes of evaluating the potential impacts of the POA's SFD Project on marine mammals. By selecting the median value to represent the ambient sound level, which is the 50th percentile of the measurements, we eliminate the few transient loud identifiable anthropogenic sound events that do not represent the true ambient sound condition of the area. This is relevant because during two of the four days (50 percent) when background measurement data were being collected, the U.S. Army Corps of Engineers was dredging Terminal 3 (located just north of the Ambient-Offshore hydrophone) for 24 hours per day with two 1-hour breaks for crew change. On the last two days of data collection, no dredging was occurring. Therefore, the median provides a better representation of background noise levels when the SFD project would be occurring, concurrent with routine anthropogenic sounds for that location. With regard to spatial considerations of the measurements, the "Ambient-Offshore" location is most applicable to this discussion as it complies with a NMFS 2012 memo providing guidance on characterizing underwater background sound[29]. The median noise level collected over four days at the end of May at the "Ambient-Offshore" hydrophone was 122.2 dB. We note the "Ambient-Dock" location was quieter, with a median of 117 dB; however, that hydrophone was placed very close to the dock and not where we would expect Level B harassment to occur given mitigation measures (*e.g.,* shutdowns). We therefore consider 122.2 dB to represent the average ambient sound level for this location and use the 122.2 dB isopleth to define the threshold distance beyond which project-generated sound no longer causes Level B harassment of marine mammals. If additional data collected in the future warrant revisiting this issue, NMFS may adjust the 122.2 dB rms Level B harassment threshold for this location.

Under the PTS Technical Guidance, NMFS uses the following thresholds (Table 7) 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 2018a). Different thresholds and auditory weighting functions are provided for different marine mammal hearing groups, which are

[29] 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.

defined in the Technical Guidance (NMFS 2018a). The generalized hearing range for each hearing group is in Table 6.

Table 7. Underwater marine mammal hearing groups (NMFS 2018).

Hearing Group	**ESA-listed Marine Mammals In the Action Area**	**Generalized Hearing Range**[1]
Low-frequency (LF) cetaceans *(Baleen whales)*	Western North Pacific DPS and Mexico 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]Represents 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).		

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.

Level A harassment radii can be calculated using the optional user spreadsheet[30] associated with NMFS Acoustic Guidance, or through modeling. In addition, NMFS uses the following threshold for in-air sound pressure levels from broadband sounds that cause Level B behavioral disturbance under section 3(18)(A)(ii) of the MMPA (16 U.S.C. § 1362(18)(A)(ii)): 100 dB_{rms} re 20µPa for non-harbor seal pinnipeds. Considering there are no known Steller sea lion haulouts within the vicinity of the POA and Steller sea lions have rarely been observed in the area, we do not expect any in-air Level B behavioral disturbance due to in-air sound.

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

Table 8. PTS Onset Acoustic Thresholds for Level A Harassment (NMFS 2018a).

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

* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.
Note: Peak sound pressure (L_{pk}) has a reference value of 1 μPa, and cumulative sound exposure level (L_E) has a reference value of 1μPa^{2}s. The subscript "flat" is being included to indicate peak sound pressure should be flat weighted or unweighted within the generalized hearing range. The subscript associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (LF, MF, and HF cetaceans, and PW and OW pinnipeds) and that the recommended accumulation period is 24 hours. The cumulative sound exposure level thresholds could be exceeded in a multitude of ways (i.e., varying exposure levels and durations, duty cycle). When possible, it is valuable for action proponents to indicate the conditions under which these acoustic thresholds will be exceeded.

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

While the ESA does not define "harass," NMFS issued guidance interpreting the term "harass" under the ESA as a means to: "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (Wieting 2016). For purposes of this consultation, any exposure to Level A or Level B disturbance sound thresholds under the MMPA constitutes an incidental "take" under the ESA and must be authorized by the ITS (Section 10 of this opinion).

6.3.3. Area of Ensonification

The area of ensonification is the area of water that will be ensonified above the acoustic thresholds in a day. Here, we describe operational and environmental parameters of the activity that were used to identify the area ensonified, which include source levels and transmission loss (TL) coefficient. Attenuated piles are those surrounded by a bubble curtain, reducing the amount of sound that is transmitted to the water beyond the curtain. It is not possible to surround the two battered piles with a bubble curtain; consequently, the noise produced by their installation will be unattenuated.

The estimated sound source levels (SSL) proposed by the POA and used in this assessment for vibratory installation of attenuated piles are based on sound levels of 24-inch and 36-inch piles measured during a sound source verification (SSV) study conducted during Phase1 of the POA's 2020 PCT project (Reyff et al. 2021). For the 24-inch template piles, SSLs measured for 24-inch PCT template piles were selected for use as a proxy for 24-inch SFD template piles based on anticipated pile function (Table 8). These piles were driven for 19.2 to 25.6 minutes, using an APE 200-6 vibratory hammer and a confined bubble curtain (Reyff et al. 2021). For the 36-inch template piles, SSLs are assumed to be similar to the SSLs measured for 36-inch trestle piles installed during PCT construction (Reyff et al. 2021) (Table 8). These piles were installed with a confined bubble curtain using an APE 300-6 vibratory hammer; driving times ranged from 22.1 to 36.4 minutes. It is assumed that SSLs during pile installation and removal for both pile sizes will be similar.

No unattenuated 24-inch or 36-inch piles were installed during either the Test Pile Program (TPP) (Austin et al. 2016) or PCT SSV projects (Reyff et al. 2021). Instead, SSL measurements collected during marine construction projects conducted by the U.S. Navy for the Naval Base Kitsap at Bangor EHW-2 Project (U.S. Navy 2015), which were installed at similar depths and in a similar marine environment, were used as proxies for vibratory and impact installation of unattenuated piles for the SFD project (Table 8).

SSLs measurements for attenuated 24-inch and 36-inch piles driven with an impact hammer also were not measured during either the TPP (Austin et al. 2016) or PCT SSV projects (Reyff et al. 2021). SSL measurements for impact installation made by Reyff et al. (2021) were on piles using a confined bubble curtain system with 48-inch piles; whereas, an unconfined system is proposed with smaller piles for the SFD. In a confined bubble curtain system, the bubbles are confined to the area around the pile with a flexible material or rigid pipe. In an unconfined bubble curtain system, there is no such system for restraining the bubbles. Unconfined bubble curtain performance is highly variable and effectiveness depends on the system design and on-site conditions such as water depth, water current velocity, substrate, and underlying geology.

The U.S. Navy (2015) summarized several studies which demonstrated that unconfined bubble curtains performance can be effective in attenuating underwater noise from impact pile installation. Based on information from the Bangor Naval Base Test Pile Program, they found an average peak SPL reduction of 8 dB to 10 dB at 10 m was an achievable level of attenuation for steel pipe piles of 36- and 48-inches in diameter. The efficiency of bubble curtains with 24-inch piles was not examined by the U.S. Navy (2015). Based on these analyses, and the effect that local currents may have on the distribution of bubbles and thus effectiveness of an unconfined bubble curtain, NMFS conservatively applies a 7 dB reduction to the U.S. Navy (2015) unattenuated SSLs for attenuated 24-inch and 36-inch piles during impact pile driving (Table 8). These SSLs are consistent with SSLs previously proposed and considered by NMFS for POA impact pile driving of 24-inch and 36-inch piles. This reduction is more conservative than the confined bubble curtain efficacy reported by Reyff et al. (2021), which ranged from 9 to 11 dB for peak, rms, and SEL single strike measurements.

The TL coefficients reported in the PCT SSV are highly variable and are generally lower than values previously reported and used in the region. For example, Reyff et al. (2021) reported unweighted transmission loss coefficients ranging from 8.9 to 16.3 dB SEL and 7.0 to 16.7 dB rms for impact driving 48-inch attenuated piles. In the PCT Final IHA (85 FR 19294), the POA proposed, and NMFS applied, a TL rate of 16.85 dB SEL for assessing potential for Level A harassment from impact pile driving and a TL rate of 18.35 dB rms when assessing potential for Level B harassment from impact pile driving for based on Austin et al. (2016) measurements recorded during the TPP on 48-in piles. Higher TL rates in Knik Arm are supported by additional studies, such as by Širović and Kendall (2009), who reported a TL of 16.4 dB during impact hammer driving during passive acoustic monitoring of the POA Marine Terminal Redevelopment Project, and by Blackwell (2005) who reported TLs ranging from 16 - 18 dB SEL and 21.8 dB rms for impact and vibratory installation of 36-inch piles, respectively, during modifications made to the Port MacKenzie dock.

After careful inspection of the data presented in the Reyff et al. (2021) study (including relevant spectrograms), NMFS is concerned that flow noise (tidal noise) in the far field measurements negatively biases the regressions derived to infer TL rates. While Reyff et al. (2021) discuss the attempts they made to remove flow noise from their calculations, NMFS could not conclude that these attempts were successful. Relevant to the SFD, the TL calculations of individual vibratory installation of 24-inch template piles and 36-inch trestle piles reported by Reyff et al. (2021) were also highly variable ranging from 12.5 to 16.6 dB rms and 14.4 to 17.2 dB rms, respectively. Given this variability and previous data suggesting higher TL rates, NMFS has determined that applying a practical spreading loss model (15logR) to ensonified area calculations is most likely the representative value for Knik Arm (Table 8). The 15 TL coefficient also falls within the range of TL coefficients reported in Reyff et al. (2021).

Table 9. Estimated sound source levels and transmission loss coefficients with and without a bubble curtain

<table>
<tr><th>Method and Pile Size</th><th colspan="5">Unattenuated</th><th colspan="5">Bubble Curtain</th></tr>
<tr><td>Vibratory</td><td colspan="3">Sound Level at 10 m (dB rms)</td><td colspan="2">TL Coefficient (dB rms)</td><td colspan="3">Sound Level at 10 m (dB rms)</td><td colspan="2">TL Coefficient (dB rms)</td></tr>
<tr><td>36-inch</td><td colspan="3">166.0a</td><td colspan="2">15.0c</td><td colspan="3">161.4b</td><td colspan="2">15.0c</td></tr>
<tr><td>24-inch</td><td colspan="3">161.0a</td><td colspan="2">15.0c</td><td colspan="3">158.5b</td><td colspan="2">15.0c</td></tr>
<tr><td rowspan="3">Impact</td><td colspan="5">Unattenuated</td><td colspan="5">Bubble Curtain</td></tr>
<tr><td colspan="3">Sound Level at 10 m</td><td colspan="2">TL Coefficient</td><td colspan="3">Sound Level at 10 m</td><td colspan="2">TL Coefficient</td></tr>
<tr><td>dB rms</td><td>dB SEL</td><td>dB Peak</td><td>dB rms</td><td>dB SEL</td><td>dB rms</td><td>dB SEL</td><td>dB peak</td><td>dB rms</td><td>dB SEL</td></tr>
<tr><td>36-inch</td><td>194.0a</td><td>184.0a</td><td>211.0a</td><td>15.0c</td><td>15.0c</td><td>187.0a</td><td>177.0 a</td><td>204.0a</td><td>15.0c</td><td>15.0c</td></tr>
<tr><td>24-inch</td><td>193.0a</td><td>181.0a</td><td>210.0a</td><td>15.0c</td><td>15.0c</td><td>186.0a</td><td>174.0a</td><td>203.0a</td><td>15.0c</td><td>15.0c</td></tr>
<tr><td colspan="11">a U.S. Navy 2015
b Reyff et al., 2021
c Practical spreading loss model</td></tr>
</table>

When the NMFS Technical Guidance (2016) was published (and revised in 2018; (NMFS 2018a)), in recognition of the fact that ensonified area/volume could be more technically challenging to predict because of the duration component in the new thresholds, NMFS Permits Division developed a user spreadsheet that includes tools to help predict a simple isopleth that can be used in conjunction with marine mammal density or occurrence to help predict takes. NMFS Permits Division notes that because of some of the assumptions included in the methods used for these tools, it is expected that isopleths produced are typically going to be overestimates to some degree (and therefore more conservative), which may result in some degree of overestimate of Level A and Level B harassment. However, these tools offer the best way to predict appropriate isopleths when more sophisticated 3D modeling methods are not available, and NMFS continues to develop ways to quantitatively refine these tools and will qualitatively address the output where appropriate. For stationary sources (such as pile driving), the NMFS User Spreadsheet predicts the closest distance at which a marine mammal would not incur PTS despite remaining at that distance throughout the duration of the activity. Inputs used in the User Spreadsheet, and the resulting isopleths are reported below (Table 9).

Table 10. NMFS User Spreadsheet Inputs

User Spreadsheet Input: Vibratory Pile Driving				
	24-inch (unattenuated)	**24-inch (bubble curtain)**	**36-inch (unattenuated)**	**36-inch (bubble curtain)**
Spreadsheet Tab Used	A.1) Non-Impul, Stat, Cont.	A.1) Non-Impul, Stat, Cont.	A.1) Non-Impul, Stat, Cont.	A.1) Non-Impul, Stat, Cont.
Source Level (SPL RMS)	161	158.5	166	161.4
Transmission Loss Coefficient	15	15	15	15
Weighting Factor Adjustment (kHz)	2.5	2.5	2.5	2.5
Time to install / remove single pile (minutes)	45 / 75	45 / 75	45 / 75	45 / 75
Piles to install / remove per day	1 / 1	1-2 / 1-3	1 / 1	1-3 / 1-3
User Spreadsheet Input: Impact Pile Driving				
	24-inch (unattenuated)	**24-inch (bubble curtain)**	**36-inch (unattenuated)**	**36-inch (bubble curtain)**
Spreadsheet Tab Used	E.1) Impact pile driving	E.1) Impact pile driving	E.1) Impact pile driving	E.1) Impact pile driving
Source Level (Single Strike/shot SEL)	181	174	184	177
Transmission Loss Coefficient	15	15	15	15
Weighting Factor Adjustment (kHz)	2	2	2	2
Number of strikes per pile	1000	1000	1000	1000
Piles per day	1	1	1	1

To calculate the Level B harassment isopleths, NMFS considered SPL_{rms} source levels and the corresponding TL coefficients (dB_{rms}; Table 9) for impact and vibratory pile driving, respectively. The resulting Level A harassment and Level B harassment isopleths are presented in Table 10.

Table 11. Distances to Level A harassment, by hearing group, and Level B harassment thresholds per pile type and installation method.

Pile Size	Attenuation	Hammer Type (Installation/Removal)	Piles per day	Level A harassment (m)					Level A harassment areas (km^2) all hearing groups	Level B harassment (m)
				LF	MF	HF	PW	OW		
24-inch	Bubble Curtain	Vibratory (Installation)	1	4	1	6	3	1	<0.01	2,631
			2	7	1	9	4	1		
		Vibratory (Removal)	1	6	1	8	4	1		
			3	12	1	17	7	1		
		Impact (Installation)	1	251	9	299	135	10	<0.19	542
	Unattenuated	Vibratory (Installation)	1	6	1	9	4	1	<0.01	3,861
		Vibratory (Removal)	1	8	1	12	5	1		
		Impact (Installation)	1	735	27	876	394	29	<1.34	1,585
36-inch	Bubble Curtain	Vibratory (Installation)	1	6	1	9	4	1	<0.01	4,106
			2	10	1	15	6	1		
			3	13	2	19	8	1		
		Vibratory (Removal)	1	9	1	13	6	1		
			3	18	2	26	11	1		
		Impact (Installation)	1	398	15	474	213	16	<0.76	631
	Unattenuated	Vibratory (Installation)	1	13	2	18	8	1	<0.01	8,318
		Vibratory (Removal)	1	18	2	26	11	1		
		Impact (Installation)	1	1,165	42	1,387	624	46	<3.14	1,848

6.4. Marine Mammal Occurrence and Exposure Estimates

For all ESA listed species, NMFS relied on marine mammal monitoring data collected during past POA projects to calculate exposure estimates. These data cover the construction season (April through November) across multiple years. For Cook Inlet beluga whales, NMFS used a multi-step analysis consisting of an evaluation of long-term/seasonal sighting data, proposed mitigation and monitoring measures, the amount of documented take from previous POA projects compared to authorized take, and considered group size. Estimated exposure from pile installation for Steller sea lions and humpbacks is calculated by the following equation: Exposure estimate = N * # days of pile installation, where: N = highest daily abundance estimate for each species in project area across all years of data.

6.4.1. Cook Inlet Beluga Whales

NMFS considered several sources of information on marine mammal occurrence in upper Cook Inlet to determine how best to estimate the potential for exposure to pile driving noise from the SFD Project. In their application, the POA estimated Level B harassment take following methods outlined in the PCT final IHA (85 FR 19294), which relied on monitoring data of Cook Inlet beluga whales collected at the POA (Kendall and Cornick 2015). For the SFD application, POA also considered monitoring data of Cook Inlet beluga whales collected during Phase 1 of the PCT project (61 North Environmental 2021a). These data sets cover all months the POA may be conducting pile driving for the SFD and they are based on all animals observed during scientific monitoring within the proximity of the SFD regardless of distance. Hourly sighting rates for Cook Inlet beluga whales for each calendar month were calculated using documented hours of observation and Cook Inlet beluga whale sightings from April through November for 2005, 2006, 2008 and 2009 (Kendall and Cornick 2015) and 2020 (61 North Environmental 2021a) (Table 11). The highest calculated monthly hourly observation rate of 0.94 whales per hour was used to calculate potential Cook Inlet beluga whale exposures (21 hours of pile installation and removal multiplied by 0.94 whales/hour). Using this method, the POA estimated that 20 Cook Inlet beluga whales (rounded from 19.75) could be exposed to the Level B harassment level during pile installation and removal associated with the construction of the SFD. These calculations assume no mitigation and that all animals observed would enter a given Level B harassment zone during pile driving.

Table 12. Summary of Cook Inlet beluga whales sighting data from April-November 2005-2009 and April-November 2020

Month	Total Hours	Total Groups	Total Whales	Whales/Hour
April	52.50	13	35	0.67
May	457.40	53	208	0.45
June	597.77	37	122	0.20
July	552.67	14	27	0.05
August	577.30	120	543	0.94
September	533.03	124	445	0.83
October	450.70	9	22	0.05
November	346.63	52	272	0.78
Data compiled from Kendall and Cornick (2015) and (61 North Environmental 2021a)				

To more accurately estimate potential exposures POA followed the methods described by NMFS for the PCT Final IHA (85 FR 19294), which looked at previous monitoring results at the POA in relation to authorized take numbers. Between 2008 and 2012, NMFS authorized 34 Cook Inlet beluga whale takes per year to POA, with mitigation measures similar to the measures proposed here. The percent of the authorized takes that occurred during this time period ranged from 12 to 59 percent with an average of 36 percent (Table 12). In 2020, NMFS authorized 55 Cook Inlet beluga whale takes in Phase 1 of the PCT project, with mitigation and monitoring measures that are consistent with those proposed for this project. Forty-seven percent of authorized takes were documented (26 out of 55 exposures; (61 North Environmental 2021a); Table 12). Given that there was extensive monitoring occurring across all IHAs (with effort intensified in 2020), we conclude there is little potential that animals were taken but not observed.

Table 13. Authorized and reported Cook Inlet beluga whales takes during POA activities from 2009-2012 and 2020

ITA effective dates	Reported takes	Authorized takes	Percent of authorized takes
15 July 2008-14 July 2009	12	34	35
15 July 2009-14 July 2010	20	34	59
15 July 2010-14 July 2011	13	34	38
15 July 2011-14 July 2012	4	34	12
1 April 2020-31 March 2021	26	55	47

As described in the POA's application, and in more detail in the Proposed Mitigation section, mitigation measures have been designed to reduce Level B harassment as well as to avoid Level A harassment. We recognize that in certain situations, pile driving may not be able to be shut down prior to whales entering the Level B harassment zone due to safety concerns. During previous monitoring, sometimes Cook Inlet beluga whales were initially observed outside of the harassment zone and a shutdown was called, but the Cook Inlet beluga whales swam into the harassment zone before activities could be halted, and exposure within the harassment zone occurred. On other occasions, Cook Inlet beluga whales were initially observed when they surfaced within the harassment zone (ICRC 2009). During Phase 1 of the PCT project all of the recorded takes (n = 26) were instances where the whales were first observed within the Level B harassment zone, prompting shutdown procedures. Most of these exposures (21 of 26) occurred when the Cook Inlet beluga whales first appeared near the northern station, just south of Cairn Point (61 North Environmental 2021a). In 2020, the northern station did not have visibility of the near shoreline north of Cairn Point. As a result, Cook Inlet beluga whales traveling south during ebb tides around Cairn Point were often inside of the Level B harassment zone upon first sighting (61 North Environmental, 2021a). As described below in the Proposed Monitoring and Reporting section, mitigation and monitoring approaches for the SFD project are modeled after the stipulations outlined in the Final IHAs for Phase 1 and Phase 2 PCT construction (85 FR 19294), but one of the PSO stations will be moved to enhance visibility to the north, especially near Cairn point. Therefore, we expect the ability to detect whales and shut down prior to whales entering the Level B harassment zones will be better than or consistent with previous years.

To account for these mitigation measures, the POA applied the highest percentage of previous takes (59 percent) to ensure potential impacts to Cook Inlet beluga whales are adequately evaluated. After applying this adjustment to account for potential exposures of Cook Inlet beluga whales that would be avoided by shutting down, the POA estimated that 12 Cook Inlet beluga whales (20 whales * 0.59 = 11.80 whales; 12 rounded up) may be exposed to Level B harassment during pile installation and removal. However, this approach does not accurately reflect the reality that Cook Inlet beluga whales can travel in large groups. Large groups of Cook Inlet beluga whales have been seen swimming through the POA vicinity during POA monitoring efforts. For example, during Phase 1 of the PCT, the mean group size was 4.34 whales; however, 52 percent of observations were of groups greater than the mean group size, with 5 percent of those 119 groups being larger than 12 individuals, the number of exposures proposed by POA (61 North Environmental 2021a).

To ensure that a large group of Cook Inlet beluga whales would not result in the POA using the majority or all of the authorized take in one or two sightings, POA increased the exposure estimate detailed above by adding a representative large group of Cook Inlet beluga whales. The 95th percentile is commonly used in statistics to evaluate risk. Therefore, to determine the most appropriate size of a large group, the POA calculated the 95th percentile group size of Cook Inlet beluga whales observed during Kendall and Cornick (2015) and 2020 Phase 1 PCT construction monitoring (61 North Environmental, 2021a); the same data used above to derive hourly sighting rates (Table 11). The 95th percentile of group size is 12.0 (Figure 22). This means that, of the 422 documented Cook Inlet beluga whale groups in these data sets, 95 percent consisted of fewer than 12.0 whales; 5 percent of the groups consisted of more than 12.0.

Taking into account the large group size, the POA requests and PR1 proposes to authorize 24 takes by Level B harassment (12 takes calculated following the methods outlined for the PCT project that accounts for mitigation plus a group size of 12) of Cook Inlet beluga whales incidental to pile driving for the SFD. No Level A harassment is expected or proposed given the small Level A harassment zones for Cook Inlet beluga whales (Table 10) and the mitigation measures specific to Cook Inlet beluga whales, including the measure that pile driving activities must shut down when any Cook Inlet beluga whale enters the relevant Level B harassment zone.

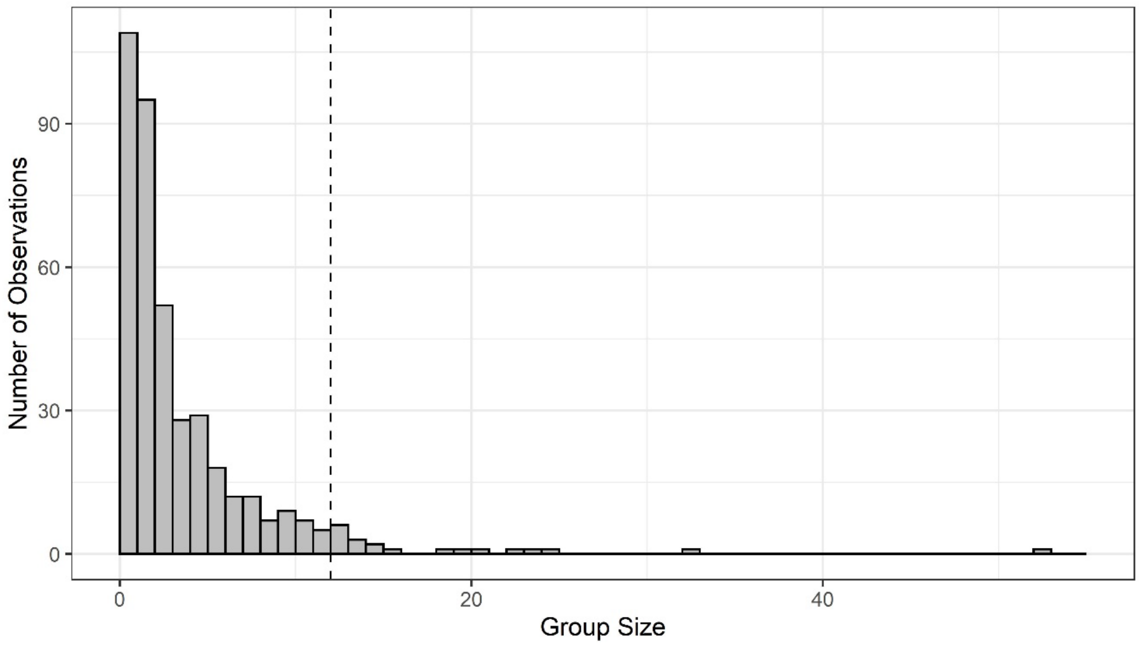

Figure 21. Cook Inlet beluga whale sighting data from Kendall and Cornick (2015) and Phase 1 of the PCT (61 North Environmental 2021a). The dashed vertical line represents the 95th percentile of group size (*i.e.*, 12 Cook Inlet beluga whales)

6.4.2. Steller Sea Lions

Steller sea lions are expected to be encountered in low numbers, if at all, within the action area. However, individual animals can linger in the area for multiple days. Three sightings of what was likely a single individual occurred near the POA in 2009, and two sightings occurred in 2016 (over 19 days of work). Based on observations in 2016, NMFS expects an exposure rate of 2 individuals every 19 days to MMPA Level B harassment, while an additional 2 individuals are expected to be exposed to MMPA Level A harassment during SFD pile installation and removal. Based on this rate, there could be up to four harassment exposures of Steller sea lions during the 24 days of SFD pile installation and removal.

Sea lions are known to travel at high speeds, can change directions rapidly, and have the potential to be counted multiple times. For these reasons, the POA anticipates that, despite all precautions, sea lions could enter the Level A harassment zone before a shutdown could be fully implemented. For example, in 2016 during the POA Test Pile Program, a Steller sea lion was first observed next to a work boat and within the Level A harassment zone. Nine PSOs had been monitoring for the presence of marine mammals near the construction activities at this time, but they did not observe the approaching sea lion. Sea lions are known to be curious and willing to approach human activity closely, and they can swim with a low profile. The incident was recorded as a Level A harassment take and raises the prospect that a sighting of a Steller sea lion within the Level A harassment zones could occur. Despite the small Level A harassment isopleths (< 46 m; Table 10) and the proposed mitigation measures, including the implementation of shutdown zones and the use of PSOs, Level A take is possible. Consequently, the proposed IHA would authorize two Level A harassment takes and two Level B harassment takes of Steller sea lions. We expect these sea lions to be from the endangered Western DPS.

6.4.3. Humpback Whale

Sightings of humpback whales in the action area are rare, and the potential risk of exposure of a humpback whale to sounds exceeding the Level B harassment threshold is low. Few, if any, humpback whales are expected to be in the action area. However, there were two sightings (over 15 days of work) in 2017 of what was likely a single individual at the Ship Creek Boat Launch (ABR 2017), which is located adjacent to the project area. Based on these data, the POA conservatively estimates that up to two individuals could be behaviorally harassed during the 24 days of pile driving for the SFD. This could include sighting a cow-calf pair or two sightings of a single humpback whale. No Level A harassment take of humpback whales is anticipated or proposed to be authorized. Of these exposures to Level B harassment, we expect that 89 percent would be from the Hawaii DPS (not listed), 10.5 percent from the threatened Mexico DPS and 0.5 percent from the endangered Western North Pacific DPS. Therefore, in all likelihood any humpback exposed to Level B harassment would be from the unlisted Hawaii DPS. However, because there is small possibility that any humpback exposed to Level B harassment would be from the threatened Mexico DPS or the endangered Western North Pacific DPS, we conservatively assume that, of the two humpbacks the POA estimates could be exposed to Level B harassment, one each would come from a listed DPS.

In summary, the total amount of Level A harassment and Level B harassment proposed to be authorized for each marine mammal is presented in Table 13.

Table 14. Proposed amount of take, by species and harassment type.

Species	Proposed Authorized Take	
	Level A	Level B
Mexico DPS Humpback whale	0	1
Western North Pacific DPS Humpback whale	0	1
Cook Inlet Beluga whale	0	24
Steller sea lion	2	2

6.5. Effects from Impact and Vibratory Pile Driving Noise

Various studies have been conducted on the behavioral responses of cetaceans and pinnipeds in the presence of pile driving (Blackwell et al. 2004; Brandt et al. 2011; Carstensen et al. 2006; Dähne et al. 2013; Haelters et al. 2012; Hastie et al. 2015; Kendall and Cornick 2015; Kendall et al. 2014; Tougaard et al. 2009; Wang et al. 2014; Würsig et al. 2000). Data indicate noise from pile driving can be detected at distances of up to 70 km (Bailey et al. 2010; Southall et al. 2007). General responses of cetaceans from noise associated with pile driving include, but are not limited to, change in vocal behavior and avoidance of the area.

6.5.1. Beluga Whales

As discussed in the *Status of the Species* section (Section 4.3.1.6), NMFS assumes that beluga whale vocalizations are partially representative of their hearing sensitivities. NMFS categorizes Cook Inlet beluga whales in the mid-frequency cetacean functional hearing group, with an applied frequency range between 150 Hz and 160 kHz (NMFS 2018a). For their social interactions, belugas emit communication calls with an average frequency range of about 200 Hz to 7 kHz (Garland et al. 2015). At the other end of their hearing range, belugas use echolocation signals (biosonar) with peak frequencies at 40 to 120 kHz (Au 2000) to navigate and hunt in dark or turbid waters, where vision is limited. Belugas and other odontocetes make sounds across some of the widest frequency bands that have been measured in any animal group. In the first report of hearing ranges of belugas in the wild, results of Castellote et al. (2014) were similar to those reported for captive belugas, with most acute hearing at middle frequencies, about 10 to 75 kHz.

Southall et al. (2007) reviewed acoustic research for mid-frequency cetaceans exposed to multiple pulses (such as impact pile driving) and found there is no indication for a clear tendency for increasing probability and severity of responses with increasing received levels (Southall et al. 2007). In certain conditions, multiple pulses at relatively low received levels (~80 to 90 dB re 1 μPa) temporarily silenced individual vocal behavior for one species (sperm whale). In other cases with slightly different stimuli, received levels in the 120-180 dB range failed to elicit observable reactions from a significant percentage of individuals either in the field or the laboratory (Southall et al. 2007).

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). In upper Cook Inlet, few studies conducted have documented beluga whale responses to pile driving activity (Castellote et al. 2018; Kendall and Cornick 2015; Kendall et al. 2014). Castellote et al. (2015) reported that weekly mean of daily beluga detection-positive hours (DPH) from Cairn Point, Point MacKenzie, and Six Mile (near sources of industrial noise) are very low compared to the DPH obtained in the quieter upper portion of Knik Arm.

A study conducted during the Port of Anchorage Marine Terminal Redevelopment (MTR) Project in Knik Arm detected an hourly click rate that was higher during times without (429 detected clicks/h) than with (291 detected clicks/h) construction activity; however, the difference was not statistically significant (Kendall et al. 2014). Kendall et al. 2014 noted that possible reasons for this difference could be: 1) lower frequency beluga whale vocalizations (e.g., whistles) were potentially masked, 2) there may have been an overall reduction in beluga vocalizations, or 3) belugas were avoiding the area during construction activity (Kendall et al. 2014). Kendall and Cornick (2015) visually observed beluga whales before and during pile driving activity at the MTR Project. They observed a decrease in sighting duration, an increase in traveling relative to other observed behaviors, and a change in group composition during pile driving activity. While areas near the POA, such as the Susitna Delta and Eagle Bay (Knik Arm) appear to be highly important areas for belugas, the immediate area around the POA itself is not believed to be an important area for essential beluga activities. Therefore, increased travel speed through the area, while indicating disturbance, likely does not indicate impairment of essential life functions.

Castellote et al. (2018) suggested that masking of beluga vocalizations likely occurs during impact pile driving activity; however, communication may occur between strikes. In another small cetacean, the Indo-Pacific humpbacked dolphin, Wang et al. (2014) suggested that vibratory pile driving noise may not adversely affect clicks produced; however, whistles produced by these dolphins are likely susceptible to auditory masking during vibratory pile driving. We note that the maximum amount of pile driving that may occur in one day (if 3 piles were driven and it takes an estimated 45 minutes for each) is two hours and 15 minutes (Table 1). However, for Phase 2 of the PCT, the average amount of time it took to drive the 36" piles (n=6) was 11.3 minutes. This information indicates that the estimated amount of time for pile driving for this project is very conservative (45 minutes/pile) and the amount of pile driving that will occur on any given day is likely much less than one hour, even if three piles are driven in one day. Therefore, any possible interference with beluga communications, if it did occur, would be extremely limited in duration.

During field observations in the Beaufort Sea, Miller et al. (2005) reported evidence of belugas avoiding large array seismic operations. Further, Romano et al. (2004) found that a captive beluga whale exposed to airgun sounds produced stress hormones with increasing sound pressure levels, and some hormone levels remained high as long as an hour after exposure (but these hormone levels were far less than those produced during beluga whale chase and capture events). Although the above observations occurred during beluga exposure to sound pressure levels above those that would be produced by the pile-driving proposed for the current project, they demonstrate that belugas are susceptible to sound-induced stress and may be behaviorally and physiologically disturbed by loud noises, potentially leading to restricted use of available habitat when such sounds are produced.

This information leads NMFS to conclude that beluga whales are likely to respond when exposed to sounds produced by pile driving operations. Of the beluga whales that may occur within the Level B harassment zone of pile driving, 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 to avoid pile driving, change their respiration rates, increase dive times, reduce feeding behavior, and/or alter vocalizations and social interactions (Frid and Dill. 2002; Funk et al. 2010; Kendall and Cornick 2015; Kendall et al. 2014; Koski et al. 2009; Melcon et al. 2012). Some whales may be less likely to visibly respond if they are foraging. Beluga whales may experience physiological stress responses if they encounter pile driving noise or attempt to avoid pile driving noise and encounter another activity in the project area while they are engaged in avoidance behavior.

The implementation of mitigation measures such as: 1) not starting pile driving if a beluga is observed within Knik Arm or appears likely to enter Knik Arm; or 2) shutting down of pile driving activities if a beluga is observed within, or likely to enter, the Level B zone; will make it very unlikely that a beluga will experience a TTS. However, in the unlikely event that a beluga does enter the Level B zone during pile driving, as described in the Threshold Shift section, the severity of TTS would depend on the duration, frequency, sound pressure, and rise time of a sound (Finneran and Schlundt 2013). If a beluga should experience TTS from noise associated with pile driving activities, a full recovery would be expected within a few days of exposure because of the temporary nature of TTS.

While the likelihood of belugas experiencing TTS is expected to be extremely low (as discussed above), of greater concern is the possibility of spatial displacement due to project activities. Noise from construction activities has been shown to cause abandonment of habitat in other marine mammals (Forney et al. 2017; Wartzok et al. 2003). The main concern in the case of this project is the potential for blocking or deterring belugas from transiting through the waters between the Port of Alaska and Point MacKenzie. Blocking passage through this constricted area is of greatest concern when belugas are traveling to and from Eagle Bay, an important foraging area for Cook Inlet belugas (Castellote et al. 2015; Joint Base Elmendorf-Richardson 2010; McGuire and Stephens 2016a). Belugas may enter Knik Arm and spend days to weeks in or near Eagle Bay before heading south (past the POA) to leave Knik Arm (Castellote et al. 2016a; Ferrero et al. 2000; Hobbs et al. 2005; Shelden et al. 2018).

Pile driving noise at the POA could inhibit beluga access to this important foraging area north of the Port, or from leaving Knik Arm by swimming south past the POA. While Eagle Bay is an area in which belugas can spend days or even weeks lingering and foraging (Castellote et al. 2015; Joint Base Elmendorf-Richardson 2010; McGuire and Stephens 2016a), it will not be ensonified by this project – but belugas traveling from south of the Port with the intention of moving into the upper Inlet (especially Eagle Bay) may be blocked or deterred from this course by noise from pile driving. However, previous studies and monitoring projects conducted during construction activities at the POA, including pile driving and dredging (Kendall and Cornick 2015), have not shown abandonment of the area during previous periods of heightened sound-producing activities. During previous POA pile driving activities, as discussed above, some changes in behavior have been noted, such as increased travelling behavior and swimming speed, more dispersed groups, and more sightings of lone individuals (Kendall and Cornick 2015), however belugas continued to travel past the POA to and from upper Knik Arm.

The implementation of project mitigation measures will decrease the likelihood of restricting belugas from passing by the POA, and decrease the likelihood of exposing belugas to noise at levels that would cause disturbance and stress. These mitigation measures include not starting pile driving if belugas are observed entering or appearing likely to enter Knik Arm or leaving Knik Arm to go to other foraging areas. The north and south PSO stations will allow the POA to detect belugas that may be heading towards the POA and ensure that pile driving does not cause them to turn away. Additionally, the intention of the mitigation measures is to ensure that the width of Knik Arm is not fully ensonified. An unconfined bubble curtain will be used on all the plumb piles, only two battered piles will be unattenuated and they will not be installed in August or September when belugas are most likely to be found in the waters near the POA. The POA will also shutdown pile driving activities if beluga whales are observed within or likely to enter the Level B harassment zone, so exposures to noise exceeding the Level B thresholds are expected to be short in duration, if they occur at all.

6.5.2. Steller Sea Lions

As discussed above, Steller sea lions are rarely observed in the action area. We do not expect noise associated with pile driving to disturb Steller sea lions at rookeries and haulouts because the nearest haulout or rookery is over 200 km from the POA (see Steller sea lion 4.3.2).

Steller sea lions that occur within the Level B harassment zone of pile driving activities may change their behavioral state by avoiding these sound fields or exhibit vigilance and raise their heads above water. In general, pinnipeds seem more tolerant of, or at least habituate more quickly to, potentially disturbing underwater sound than do cetaceans, and generally seem to be less responsive to exposure to industrial sound than most cetaceans, although most of these studies were conducted on ringed and bearded seals, with a few on other phocids (although see Costa et al. (2003)). Very few studies have been conducted on otariids (although see Norberg (2000) and for additional review see Appendix B and C of Southall et al. (2007).

For Steller sea lions in particular, monitoring completed at the Kodiak Ferry Terminal and Dock Improvements Project documented 4 percent of Steller sea lions observed in the Level B exposure area (51 of 1,281) exhibited behaviors associated with disturbance, and five of these observations appeared to be reactions to passing vessels or killer whales, rather than construction activity (ABR. Inc. 2016).

Steller sea lions that occur within the Level B harassment zone are not likely to experience significant disruptions of their normal behavioral patterns because the ensonified area is temporary and pinnipeds seem rather tolerant of low frequency noise. TTS may occur if a Steller sea lion is within the Level B harassment zone. If a Steller sea lion should experience TTS from noise associated with pile driving activities, a full recovery would be expected within a few days of exposure because of the short-term nature of this condition (see Threshold Shift section). NMFS expects that few (if any) exposures would occur at received levels >160 (impulsive pipe driving) or > 122.2 dB (non-impulsive vibratory pile driving) due to avoidance of high received levels, the fact that Steller sea lions are rarely in the action area, and the constant monitoring of the100 meter shutdown zone for sea lions.

6.5.3. Humpback Whales

As discussed above, humpback whales are rarely observed in the action area. However, if humpback whales are in the action area, their most likely response to noise disturbance would be to avoid the area (Richardson et al. 1995b). Baleen whales have shown strong overt reactions to impulsive noises, at received levels between 160 and 173 dB_{rms} re 1 μPa (Gailey et al. 2007; Ljungblad et al. 1988; McCauley et al. 2000; Miller et al. 2005; Richardson et al. 1986). TTS may occur if a humpback whale is within the Level B harassment zone, however, a full recovery would be expected within a few days of exposure because of the temporary nature of TTS. Refer to the Threshold Shift (6.2.1) section for more detail on TTS.

Humpback whales are more frequently observed in lower Cook Inlet. Their large size and obvious blows make them easy to spot compared to other marine mammals that might be seen at the POA. It is expected that few humpback whales (if any) will be exposed to pile driving noise at the POA. However, if a humpback whale is within the ensonified area, we expect that these activities will likely disturb that individual. Expected responses to pile driving may include avoidance of the area where the activities are occurring, and change in vocal behavior. NMFS expects that few (if any) exposures would occur at received levels >160 (impulsive pile driving) or > 122.2 dB (non-impulsive vibratory pile driving) due to the humpback whales avoidance of high received levels, humpback whales being rare in the action area, and the shutdown zones for humpback whales.

6.6. Minor Stressors on ESA Listed Species

6.6.1. Vessel Noise, Presence, and Strikes

The proposed action is not expected to increase the number of vessels that transit to and from the POA or SFD. As described in the proposed activities, the project itself will need few auxiliary vessels. Auditory or visual disturbance to listed species could occur during vessel activities associated with project construction or use of SFD. 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.

Beluga whales' behavioral responses to vessels include changing swimming direction, increasing swim speed, altering diving, surfacing, and breathing patterns, and changes in vocalizations (Wartzok et al. 2003). Individual animals' past experiences with vessels, age, and activity at the time that they encounter the vessel appear to be important in determining an individual's response (McQuinn et al. 2011; Wartzok et al. 2003). Older animals respond more often than younger animals, and if belugas were feeding or traveling, they responded less often than during other activities. However, when they did respond, their response was more pronounced (Blane and Jaakson 1994; Fish and Vania 1971; Stewart et al. 1982). Belugas in the Canadian high Arctic reacted to noise from icebreakers, especially higher frequency components of the icebreaker noise, up to 80 km away (Cosens and Dueck 1988; Finley et al. 1990), however, this strong response may be due in part to the whales' unfamiliarity with vessel noise in this normally quiet area.

In contrast, using acoustic recorders in Cook Inlet, Small et al. (2017) found that beluga presence in three sites (Eagle Bay, Trading Bay, and Tuxedni Bay) was not influenced by time elapsed since an anthropogenic noise was detected, suggesting that Cook Inlet belugas were not affected by the noises that were detected. The authors noted that these three sites were also some of the quietest sites in Cook Inlet when compared with acoustic data from other sites in Cook Inlet analyzed in other ongoing studies.

Belugas have been found to change their vocalization frequency and intensity in response to noise in their environment (Au et al. 1985). Lesage et al. (1999) and Scheifele et al. (2005) found that noise from vessels affected beluga vocalizations in the St. Lawrence River, with changes observed in calling rates, repetition of calls, increase in call duration, and upward shift in frequency. The effects lasted longer in response to a large ferry versus smaller motorboats in the area. The St. Lawrence River population of belugas exhibit these ship noise-induced effects despite living in an area with high vessel traffic, indicating that these belugas have not become habituated to vessel noise. Changes in calling rates and duration have been reported in belugas and other cetaceans in response to noisy environments (Dunlop et al. 2014; Erbe et al. 2018; Finley et al. 1990; Wright et al. 2007). Additionally, repetition of calls has been reported to be an alarm response in high Arctic belugas (Finley et al. 1990; Sjare and Smith 1986).

Vessel collisions with marine mammals can lead to the death of the animal. An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or a vessel's propeller could injure or kill an animal below the water's surface. Ship strikes of smaller cetaceans such as beluga whales are much less common, possibly due to their smaller size and more agile nature. However, while likely rare, vessel strikes of belugas have been documented in the St. Lawrence River Estuary (Lair et al. 2015). In Cook Inlet, a dead beluga whale washed ashore in 2007 with "wide blunt trauma along the right side of the thorax" (NMFS 2008a), suggesting a ship strike was the cause of the injury. In October 2012, a necropsy of another Cook Inlet beluga carcass indicated the most likely cause of death was "blunt trauma such as would occur with a strike with the hull of the boat" (NMFS AKR, unpub. data). Scarring consistent with propeller injuries has also been documented among Cook Inlet belugas (McGuire et al. 2011). Smaller boats that travel at high speed and change direction often present a greater threat than larger, slower vessels that move in straight lines.

Similar to belugas, the agility of Steller sea lions is likely to preclude vessel strikes. Although risk of ship strike has not been identified as a significant concern for Steller sea lions (Loughlin and York 2000), the recovery plan for this species states that Steller sea lions may be more susceptible to ship strike mortality or injury in harbors or in areas where animals are concentrated (e.g., near rookeries or haulouts) (NMFS 2008b). In 2007, a Steller sea lion was found in Kachemak Bay that may have been involved in a boat collision. The Steller sea lion had two separate wounds consistent with blunt trauma (NMFS Alaska Regional Office Stranding Database accessed May 2019). Steller sea lions are not concentrated in any locations near the POA.

Humpback whales are rarely observed in the action area and vessels needed in support of project activities will travel at slow speeds and will only have localized travel within the POA. The POA will cease operations or reduce vessel speed to the minimum level required to maintain steerage and safe working conditions if a marine mammal approaches a vessel (Mitigation Measures 15 and 16). These mitigation measure will minimize the risk of collision for any humpback 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 may exist, but is unlikely because vessels will be operating at speeds that will allow primary prey to avoid collisions.

Based on the localized vessel activity in close proximity to the POA, slow vessel speeds, the implementation of mitigation measures to minimize exposure to vessel activities related to construction, and the rarity of collisions with marine mammals in Cook Inlet, NMFS concludes that the probability of a project vessel striking a Cook Inlet beluga whale, Western DPS Steller sea lion, or a humpback whale is very small, and thus adverse effects to Cook Inlet beluga whales, Western North Pacific DPS or Mexico DPS humpback whales, or Western DPS Steller sea lions are extremely unlikely to occur.

6.6.2. Pile Driving Noise and Prey

Literature reviews on the effects of sound on fish (Popper and Hastings 2009) conclude little is known about these effects and that it is not yet possible to extrapolate from one experiment to other signal parameters of the same noise, to other types of noise, to other effects, or to other species (Popper and Hawkins 2019). There are very few experimental examples of sound being sufficiently loud to result in death or mortal injury to fishes (Popper and Hawkins 2019). Limited available scientific literature indicates that noise can evoke a variety of responses from fish. Pile driving can induce a startle response and/or an avoidance response, and can cause injury or death to fish close to the noise source (Casper et al. 2012; Halvorsen et al. 2012; McCauley et al. 2003; Slabbekoorn et al. 2010). It is likely that fish will avoid sound sources within ranges that may be harmful (McCauley et al. 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 stops is unknown, but a rapid return to normal recruitment, distribution, and behavior is expected.

Of all known Cook Inlet beluga and Steller sea lion prey species, only coho salmon (*Oncorhynchus kisutch*) have been studied for effects of exposure to pile driving noise (Casper et al. 2012; Halvorsen et al. 2012). These studies defined very high noise level exposures (210 dB_{rms} re: 1µPa) as threshold for onset of injury. Rodkin (2009) studied the effects to juvenile coho salmon from pile driving of sheet piles at the Port of Anchorage in Knik Arm of Cook Inlet. The fish were exposed to in-situ noise from vibratory or impact pile driving at distances ranging from less than 1 meter to over 30 meters. The results of this study showed no mortality of any test fish within 48 hours of exposure to the pile driving activities. Subsequent necropsies showed no effects or injuries as a result of the noise exposure. The effects of noise on other Cook Inlet beluga, Steller sea lion, or humpback whale prey species, such as euphausiids, eulachon, herring, capelin, gadids, pollock, and flounder species (Krieger and Wing 1986; NMFS 2008b; NMFS 2016b) is unknown. The very low number of Steller sea lions and humpback whales that occur in upper Cook Inlet indicates prey for these species is likely limited in the action area.

Because of the very short amount of time pile driving is expected to occur on any given day, the fact that no prey mortality is expected, the localized response of prey species, and the rapid return of any temporarily displaced species, the effects of pile driving on prey species is expected to be immeasurably small.

6.6.3. Sea Floor Disturbance and Turbidity

POA is moving an existing dock, and permanent impacts from the presence of the structure is expected to be minimal. Pile installation may temporarily increase turbidity. However, increases would be temporary, localized, and difficult to detect in these waters which always have a very high concentration of suspended solids as a consequence of glacial runoff and extreme tidal exchange. POA must comply with state water quality standards during these operations by limiting the extent of turbidity to the immediate project area. In general, turbidity associated with pile installation is localized to about a 25-foot (7.6 m) radius around the pile (Everitt et al. 1980), therefore, no impacts to Ship Creek or critical Cook Inlet beluga whale foraging habitats are expected. Because of shutdown mitigation measures, cetaceans are not expected to be close enough to the project activity areas to experience effects of turbidity, and pinnipeds could avoid localized areas of turbidity. Because of the localized effects, the short time expected for pile installation and removal, effects to prey are expected to be immeasurably small. Likewise, any effects to ESA-listed species or Cook Inlet beluga whale critical habitat from seafloor disturbance and increased turbidity levels would be immeasurably small.

6.6.4. Trash and Debris

The SFD 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.

6.6.5. 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. Since an ESA consultation was completed for this general permit, impacts associated with marine vessel discharges have already been considered and any incidental take accounted for previously.

Accidental spills could occur from a leak or onboard spill either during construction activities or use of the SFD. The size of the spill influences the number of individuals that will be exposed to spilled material and the duration of that exposure. Contact through the skin, eyes, or through 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 the inhalation of the volatile toxic hydrocarbon fractions of fresh oil, which can damage the respiratory system (Hansen 1985; Neff 1990), cause neurological disorders or liver damage (Geraci and St. Aubin 1990), have anaesthetic effects (Neff 1990), and cause death (Geraci and St. Aubin 1990). However, for small spills there is expected to be a rapid dissipation of toxic fumes into the atmosphere from rapid aging of fresh refined oil, which limits potential exposure of whales to prolonged inhalation of toxic fumes.

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 a small oil spill that results in exposure of Cook Inlet beluga whales, humpback whales, Steller sea lions or their prey to spilled product is extremely unlikely to occur.

7. Cumulative Effects

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

All of the types of activities described in the Environmental Baseline (Section 5) are expected to continue into the future. Some continuing non-Federal activities are reasonably certain to contribute to climate change within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 5).

While many of the activities (e.g., oil and gas development and coastal development) described in the Environmental Baseline are expected to occur into the future, most of these activities likely have a Federal nexus and will require ESA section 7 consultation. Activities without a Federal nexus that are expected to continue into the future include 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)

Fishing, a major industry in Alaska, is expected to continue in Cook Inlet. As a result, there will be continued risk to marine mammals of prey competition, ship strikes, harassment, and entanglement in fishing gear. For Cook Inlet beluga whales, there is also a risk of continued displacement from former summer foraging habitat due to human activity associated with salmon harvest (Ovitz 2019).

NMFS assumes that ADF&G will continue to manage fish stocks and monitor and regulate fishing under their jurisdiction in Cook Inlet to maintain sustainable stocks. 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 Team considered reduction in availability of prey due to activities such as fishing to be a moderate threat to the population.

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 and beluga whale habitat. 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 and Recreational Boating

There currently are no commercial whale-watching companies in upper Cook Inlet. The popularity of whale watching and the close proximity of beluga whales to Anchorage make it possible that such operations may exist in the future. This is very unlikely to occur, however, due to extremely hazardous environmental conditions, a lack of harbors, and only one boat launching facility in the Anchorage area. Some aircraft have circled around 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.”

Avoidance reactions have often been observed in beluga whales when approached by watercraft, particularly small, fast-moving craft that are able to maneuver quickly and unpredictably; larger vessels that do not alter course or speed often cause little to no reaction among whales in Cook Inlet (NMFS 2008a). The small size and low profile of beluga whales, and the poor visibility within the Cook Inlet waters, may increase the temptation for whale watchers and other small watercraft operators to approach the beluga whales more closely than the 100-m minimum approach distance recommended by NMFS marine mammal viewing guidance (https://alaskafisheries.noaa.gov/pr/mm-viewing-guide). However, there is little if any waterborne whale watching traffic in beluga habitat, and small watercraft traffic levels in general are very low, except for in a few isolated locations such as the mouth of Twentymile River.

Watercraft have been observed to harass belugas in the Twentymile River during April. It is likely that such harassment also occurs during late summer coho salmon runs in the same area.

Structured observation efforts from August 10-October 9, 2018, indicate belugas presence in these waters on 12 of 22 occasions (Beluga Whale Alliance, unpublished data). NMFS is cooperating with partners to assess the degree to which such boating activities may be a cause for concern due to the associated reduced access to concentrations of prey.

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 and critical habitat (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. Cetacean Risk Analysis

Based on the results of the Exposure and Response Analysis, we expect Cook Inlet beluga whales and Western North Pacific DPS and Mexico DPS humpback whales may be adversely affected by exposure to pile driving noise. With the implementation of mitigation measures, exposure to vessel noise and presence, sea floor disturbance, and small oil spills may occur, but the expected effects are considered immeasurably small and/or extremely unlikely to occur and are not expected to result in take. We expect the impacts on marine mammal prey from the proposed action to be immeasurably small. Finally, exposure to vessel strike and marine debris is extremely unlikely to occur.

Our consideration of probable exposures and responses of listed whales to pile driving activities associated with the proposed action is designed to help us assess whether those activities are likely to increase the extinction risks or jeopardize the continued existence of listed whales.

We expect that the implementation of mitigation measures (see Section 2 for detailed information on the mitigation measures, and a summary listed below) will further reduce the impacts of these sounds to listed cetaceans, and we have considered these mitigation measures as part of the proposed action in our risk analysis.

Based on the activities proposed for the SFD, the Permits Division estimated 24 Cook Inlet beluga whales and 2 humpback whales (including Western North Pacific DPS and Mexico DPS humpback whales) could be exposed to Level B harassment resulting in take.

For Cook Inlet beluga whales, the effects of the action and resulting risk to the species is analyzed based on a maximum of 24 belugas exposed to Level B harassment. Because it is not possible to identify a humpback whale by DPS in the field without photo-identification linking the animal to its breeding grounds, NMFS AKR uses the estimated percentage of humpback whales by DPS to determine the number of listed animals that are likely to experience Level B harassment resulting in take. Of the humpback whales in the action area, DPS (89 percent probability) 10.5 percent are predicted to be from the Mexico DPS and 0.5 percent are predicted to be from the Western North Pacific DPS (Wade et al. 2016). Therefore, in all likelihood any humpback exposed to Level B harassment would be from the unlisted Hawaii DPS. However, because there is small possibility that any humpback exposed to Level B harassment would be from the threatened Mexico DPS or the endangered Western North Pacific DPS, we conservatively assume that the two humpbacks which could be exposed to Level B harassment would each come from a listed DPS. Thus, we expect less than 1 instance of humpback whale take from each listed DPS.

These estimates represent the total number of takes that could potentially occur, but not necessarily the number of individuals taken, as a single individual may be taken multiple times over the course of the proposed action.

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

As we discussed in the Approach to the Assessment section of this opinion, an action that is not likely to reduce the fitness of 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 the sound created by pile driving will reduce the fitness of any individual whales. 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 DPS or Western North Pacific DPS humpback whale. As a result, the proposed action is not likely to appreciably reduce the Cook Inlet beluga, Mexico DPS or Western North Pacific DPS humpback whales' likelihood of surviving or recovering in the wild.

8.1.1. Humpback Whales (Mexico and Western North Pacific DPSs)

The strongest evidence supporting the conclusion that the proposed action will likely have minimal impact on humpback whale populations is the fact that upper Cook Inlet is rarely used by humpback whales. In addition, as noted above, the best available information indicates that humpbacks seen in Cook Inlet are likely from the non-listed Hawaii DPS (89 percent probability) rather than the Mexico DPS (10.5 percent) or Western North Pacific DPS (0.5 percent).

Mitigation measures will reduce exposure of listed whales to loud noise from the action by putting into place measures that facilitate early detection of approaching marine mammals and reduction of acoustic output if marine mammals appear likely to enter associated disturbance zones. Individual humpback whales may experience Level B acoustic harassment, may experience masking, and may exhibit behavioral responses from project activities. Therefore, we expect these whales may experience stress responses. If whales are not displaced and remain in a stressful environment (i.e., within the behavioral harassment zone), we expect the stress response will dissipate shortly after the individual leaves the area or after the cessation of the acoustic stressor. TTS may occur if a listed humpback is within the Level B harassment zone; however, the severity of TTS depends on the duration, frequency, sound pressure, and rise time of a sound (Finneran and Schlundt 2013). Although pile driving noise is likely to cause individual whales to experience changes in their behavioral states that might have adverse consequences (Frid and Dill. 2002), these responses are not likely to alter the physiology, behavioral ecology, or social dynamics of individual whales in ways or to a degree that would reduce their fitness.

Based on the best information currently available, the proposed action is not expected to appreciably reduce the likelihood of survival and recovery of Mexico DPS or Western North Pacific DPS humpback whales.

8.1.2. Cook Inlet Beluga Whales

NMFS estimated the Cook Inlet beluga population to be about 279 animals as of 2018, with a 10-year (2008-2018) declining trend of 2.3 percent per year (Shelden and Wade 2019). Following the discontinuation of the subsistence harvest, NMFS expected a 2 to 6 percent recovery annually (NMFS 2008a). The trend reported in Shelden and Wade (2019) indicates the population was initially increasing but then started declining after 2010. The summer range of belugas in Cook Inlet has contracted steadily since the late 1970s (Figure 7). Whereas Cook Inlet beluga whales formerly made more extensive summer use of the waters at the mouths of the Kenai and Kasilof Rivers, they now make little to no use of this salmon-rich habitat during summer salmon runs.

Coastal development and boat traffic, especially near Anchorage, has the potential to disrupt beluga whale behavior and may alter movements among important summer habitat patches through acoustic disruption (e.g., pile driving may hinder passage to or from Knik Arm from the Susitna Delta area). Seismic exploration in upper Cook Inlet has caused both Level A and Level B takes of Cook Inlet beluga whales. Aircraft have been observed to cause behavioral changes in feeding groups of Cook Inlet beluga whales in the Susitna Delta when aircraft circled those groups. Pollution and contaminants were listed as low relative concern for impeding the recovery of Cook Inlet beluga whales (Muto et al. 2020; NMFS 2016b). Only one known beluga whale mortality associated with fisheries interaction was reported in over 10 years. There is no current subsistence harvest of Cook Inlet beluga whale.

Pile driving noise at the POA could restrict beluga access to important foraging areas north of the Port, or from leaving Knik Arm by swimming south past the port. During previous POA pile driving activities, some changes in behavior have been noted, such as increased travelling behavior and swimming speed, and group composition (Kendall and Cornick 2015), however belugas continued to travel past the POA into upper Knik Arm (especially to access Eagle Bay), and leave Knik Arm. Belugas have also continued to travel past the POA during yearly dredging operations (POA 2019, USACE 2019). With the proposed mitigation measures, we expect that belugas will continue to travel past the POA to and from feeding areas during the SFD project.

Anthropogenic noise in Cook Inlet remains a concern regarding the recovery of the DPS; however, little is known regarding how possible threats, alone or cumulatively, are impacting recovery of the Cook Inlet beluga whale DPS (NMFS 2016b).

The implementation of the mitigation measures will decrease the likelihood of exposing belugas to noise at received levels that could cause Level B harassment, disturbance, or stress. Additionally, the measures are intended to reduce the likelihood of restricting belugas from passing by the POA. These mitigation measures include not starting pile driving if belugas are observed passing into or out of Knik Arm, or appear likely to do so. One of the PSO stations will be near Point Woronzof with the intention that this observer station will be able to detect belugas that may be heading towards the POA and require shutdowns if belugas enter or are likely to enter the Level B harassment zone, thus ensuring that pile driving does not cause them to turn away. Similarly, the purpose of a PSO station north of the POA will be to monitor for belugas (and to order shutdowns if belugas enter or are likely to enter the Level B harassment zone) to ensure that belugas can travel south past the POA. Additionally, the intention of the mitigation measures is to ensure that the width of Knik Arm is not fully ensonified. An unconfined bubble curtain will be used on all plumb piles which will reduce the area of ensonification. The two battered piles, on which a bubble curtain cannot be used, will not be installed in August or September, the months when belugas are most likely to be present in greatest numbers in Knik Arm. The POA will also shutdown pile driving activities if beluga whales are observed within or likely to enter the Level B harassment zone, therefore, exposure to Level B thresholds are expected to be short in duration.

As discussed in Section 6.6.2 (Pile Driving Noise and Prey), fish may respond to noise associated with the proposed action by avoiding the immediate area. However, the expected impact of noise on marine mammal prey is very minor.

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.

8.2. Western DPS Steller Sea Lion Risk Analysis

Based on the results of the Exposure Analysis, we expect Western DPS Steller sea lions may experience Level A and B harassment through exposure to underwater noise from pile driving. Exposure to vessel noise and presence, seafloor disturbance and turbidity, marine debris, and small oil spills may occur, but such exposure would have a very small impact, and we conclude that these stressors are unlikely to result in take of sea lions. The probability of impacts on marine mammal prey items occurring from the proposed project is very small, and thus adverse effects are extremely unlikely to occur.

Exposure to vessel noise and presence, sea floor disturbance and turbidity, trash and debris, and unintentional discharge of petroleum may occur as part of the proposed action, however, with the implementation of mitigation measures, the effects are considered highly unlikely to occur or extremely small in impact. One Steller sea lion was reported within the action area with two separate head wounds consistent with blunt trauma, with suspected vessel strike as the cause of the trauma (NMFS AKR Stranding Database). There are no other reported vessel collisions or propeller strikes of Steller sea lions in Cook Inlet. Ship traffic is unlikely to increase due to the proposed action and the slow vessel speeds for project vessels do not pose a risk to the highly maneuverable Steller sea lions. Therefore, we consider additional strikes resulting from this action to be improbable. 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. Best practices regarding waste management (cutting loops prior to disposal) will further reduce the impact of debris on Steller sea lions. 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 dispersion due to tide-induced turbulence and mixing, and the safeguards in place to avoid and minimize oil spills, we expect any effects to Steller sea lions would be too small to detect or measure.

Our consideration of probable exposures and responses of Western DPS Steller sea lions to noise from pile driving associated with the proposed action is designed to help us assess whether those activities are likely to increase the extinction risks or jeopardize the continued existence of Western DPS Steller sea lions. Implementation of mitigation measures for pile driving will further reduce the potential impacts to Western DPS Steller sea lions.

The primary mechanism by which the behavioral changes we have discussed affect the fitness of individual animals is through the animal's energy budget, time budget, or both (the two are related because foraging requires time). Most adult Steller sea lions occupy rookeries during the pupping and breeding season, which extends from late May to early July (NMFS 2008b). The closest Steller sea lion rookeries or haulouts (including the nearest designated critical habitat) are over 200 km away from the action area (58 FR 45269, Figure 13). High concentrations of Steller sea lions occur in and around lower Cook Inlet, however, they are rare in upper Cook Inlet. If Steller sea lions are within the action area, the individual and cumulative energy costs of the behavioral responses we have discussed are not likely to measurably reduce the energy budgets of those Steller sea lions. As a result, the Steller sea lions' probable responses (i.e., tolerance, avoidance, short-term masking, and short-term vigilance behavior) to close approaches by vessel operations and their probable exposure to noise from pile driving are not likely to reduce their current or expected future reproductive success or reduce the rates at which they grow, mature, or become reproductively active. Therefore, these exposures are not likely to reduce the abundance, reproduction rates, or survival and growth rates of the population those individuals represent.

The take estimates (two from Level A harassment and two from Level B harassment) represent the maximum number of takes that may be expected to occur from the proposed action, but not necessarily the number of individuals taken, as a single individual may be taken multiple times over the course of the proposed action. Mitigation measures will reduce exposure of Western DPS Steller sea lions to loud noise from the action by putting into place measures that facilitate early detection of approaching marine mammals and reduction of acoustic output if marine mammals appear likely to enter associated disturbance zones.

Noise from pile driving is likely to cause some individual Steller sea lions to experience changes in their behavioral states that might have adverse consequences (Frid and Dill. 2002). However, these responses are not likely to alter the physiology, behavioral ecology, or social dynamics of individual Steller sea lions in ways or to a degree that would reduce their fitness. While a single individual may be exposed to harassing levels of sound multiple times over the course the proposed action, the implementation of mitigation measures to reduce exposure to high levels of pile driving noise reduces the likelihood of exposure to action-related noise capable of affecting vital life functions. In most circumstances, we assume Steller sea lions will avoid ensonified areas that may cause TTS or PTS. Steller sea lions that avoid these sound fields or encounter them briefly are not likely to experience significant disruptions of their normal behavior patterns. Southall et al. (2007) reviewed literature describing responses of pinnipeds to continuous sound and reported that the limited data suggest exposures between ~90 and 140 dB_{rms} re 1 μPa generally do not appear to induce strong behavioral responses in pinnipeds exposed to continuous sounds in water.

The strongest evidence supporting the conclusion that the proposed action will not impact the Western DPS Steller sea lion population is that Steller sea lions do not use upper Cook Inlet to any appreciable degree. The endangered Western DPS Steller sea lion population is increasing at ~2 percent per year (between 2000 to 2015) throughout its range (Muto et al. 2020), but continues to decline in more western portions of that range. In the region of this project, the population of non-pups is increasing at 2.68 percent per year, while the number of pups counted were increasing at 2.82 percent per year from 2000 through 2015 (Muto et al. 2020), despite the mortality or serious injury of an estimated 307 animals per year. Between 2010 and 2014, a mean annual mortality and serious injury rate of 30 animals is due to federally-regulated commercial fishing. An estimated 15 Western DPS animals/year were killed or seriously injured by state-managed fisheries when these fisheries were observed in 1990 and 1991. NMFS stranding database indicates an additional 1.6 Western DPS animals were killed or seriously injured per year in 2010 through 2014 due to interaction with commercial fishing gear from unknown fisheries and 3.0 Western DPS animals per year were killed or seriously injured due to non-fishery-related and non-subsistence-related causes during that same time period. An estimated 230 animals are harvested each year for subsistence use.

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

As we discussed in the Approach to the Assessment section of this opinion, an action that is not likely to reduce the fitness of individual sea lions would not be likely to reduce the viability of the population those individual sea lions represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of the Western DPS). For the same reasons, an action that is not likely to reduce the viability of the population is not likely to increase the extinction probability of the Western DPS Steller sea lion. As a result, the proposed action is not likely to appreciably reduce the Western DPS Steller sea lion's likelihood of surviving or recovering in the wild.

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.

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, Western North Pacific DPS or Mexico DPS humpback whales, or Western DPS Steller sea lions. NMFS concurs that the proposed action is not likely to adversely affect 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 is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity (50 CFR § 402.02). Based on NMFS guidance, the term "harass" under the ESA means to: "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (Wieting 2016). The MMPA defines "harassment" as: any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment] (16 U.S.C. § 1362(18)(A)(i) and (ii)). For this consultation, the Permits Division and USACE expect that most take will be by Level B harassment, however small numbers (2) of Level A takes are being authorized for Steller sea lions.

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, 62314; 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 and the exemption from Section 9 of the ESA become effective only upon the issuance of MMPA authorization to take the marine mammals identified in this opinion**. Absent such authorization, this incidental take statement is inoperative. Take must occur in compliance with all terms, conditions, and requirements included in the MMPA authorizations and with this Opinion and the associated ITS.

The terms and conditions described below are nondiscretionary. The 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 Permits Division and USACE 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 the 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 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).

As discussed in Section 6 of this opinion, NMFS is reasonably certain the proposed activities for the South Floating Dock in the POA are likely to result in the incidental take of ESA-listed species by Level A (2 western DPS Steller sea lions) and Level B harassment (24 Cook Inlet beluga whales, 2 humpback whales, and 2 western DPS Steller sea lions), associated with noise from pile driving (Table 14). For a breakdown of calculations and exposure by stressor see Sections 6.3 and 6.4.

Table 15 . Proposed amount of take, by species and harassment type.

Species	Proposed Authorized Take	
	Level A	Level B
Mexico DPS Humpback whale	0	1
Western North Pacific DPS Humpback whale	0	1
Cook Inlet Beluga whale	0	24
Steller sea lion	2	2

Because it is not possible to identify a humpback whale by DPS in the field without photo-identification linking the animal to its breeding grounds, NMFS AKR uses the estimated percentage of humpback whales by DPS to determine the number of listed animals that are likely to be taken. Apportioning those takes by DPS yields fractions of one humpback whale take for each of the two ESA-listed DPSs. Given the relatively small likelihood that an individual humpback whale affected by the project is from one of the ESA-listed DPSs, and that it is not possible to distinguish between DPSs in the field, we will consider the ESA-authorized take limit to be exceeded when the POA exceeds its MMPA-authorized limit on Level B harassment of any humpback whales (i.e., the authorized take limit will have been reached when any two humpback whales have been taken).

10.2. Effect of the Take

In Section 9 of this opinion, NMFS determined that the level of expected take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the Cook Inlet beluga whale, Mexico DPS humpback whale, Western North Pacific DPS humpback whale, or Western DPS Steller sea lion. We concur that the proposed SFD will not likely adversely affect Cook Inlet beluga whale critical habitat.

Although the biological significance of the expected behavioral responses of Cook Inlet beluga whales, Mexico DPS humpback whales, Western North Pacific DPS humpback whales, and Western DPS Steller sea lions remains unknown, this consultation has assumed that exposure to disturbances associated with the POA's 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, and Western North Pacific DPS humpback whales will be by incidental (MMPA Level B) acoustic harassment only (i.e., behavioral disturbance or temporary [hearing] threshold shift). Western DPS Steller sea lions may be taken by either Level B harassment (n=2) or Level A harassment (n=2), which may result in permanent hearing threshold shifts or other types of non-serious injury.

10.3. Reasonable and Prudent Measures

Reasonable and prudent measures (RPMs) are those actions "necessary or appropriate to minimize the impacts, i.e., amount or extent, of incidental take" (50 CFR § 402.02). RPMs are nondiscretionary.

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 RPM is necessary and appropriate to minimize or to monitor the incidental take of Cook Inlet beluga whales, Mexico DPS humpback whales, Western North Pacific DPS humpback whales, and Western DPS Steller sea lions resulting from the proposed action.

1. The NMFS Permits Division, USACE, and POA must monitor for and report all authorized and unauthorized take and assess 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, the action agencies must submit a report to NMFS AKR that evaluates the mitigation measures and reports the results of the monitoring program.

10.4. Terms and Conditions

"Terms and conditions" implement the reasonable and prudent measures (50 CFR § 402.14). These must be carried out for the exemption in section 7(o)(2) to apply.

In order to be exempt from the prohibitions of section 9 of the ESA, the Permits Division and USACE or any applicant must comply with the following terms and conditions, which implement the RPMs described above and the mitigation measures set forth in Section 2.1.2 of this opinion. The 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).

Partial compliance with these terms and conditions may result in more take than expected and may invalidate this take exemption. These terms and conditions constitute no more than a minor change to the proposed action because they are consistent with the basic design of the proposed action.

To carry out RPM #1, NMFS Permits Division, USACE or POA must undertake the following:

1.1 Report the taking of any marine mammal in a manner other than that authorized in this ITS within 24 hours to NMFS AKR, Protected Resources Division at 907-586-7638.

1.2 In the event that an unauthorized take of marine mammal may have occurred, the POA must implement a safe and prompt shutdown of in-water work and immediately report the incident to NMFS AKR, Protected Resources Division at 907-586-7638 to jon.kurland@noaa.gov, to the Marine Mammal Stranding Hotline at 877-925-7773, and to NMFS Permits Division (Jaclyn Daly, Jaclyn.daly@noaa.gov or 301-427-8484).

The report must include the following information:

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

ii. details on the nature and cause of the take (e.g., vehicles, vessels, and equipment in use at the time of take);

iii. an account of all known sound sources above 120 dB that occurred in the 24 hours preceding the incident;

iv. water depth at the location of the take;

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

vi. description of marine mammal observations in the 24 hours preceding the incident;

vii. species identification or description of the animal(s) involved;

viii. the fate of the animal(s);

ix. and any photographs or video footage of the animal obtained.

Activities that may have caused the take must cease upon the occurrence of unauthorized take and must not resume until NMFS is able to review the circumstances of the prohibited take. USACE and NMFS Permits Division must work with NMFS AKR and the applicant to determine what is necessary to minimize the likelihood of additional prohibited take and ensure ESA compliance. The applicant must not resume the suspended activity until notified by NMFS via letter, email, or telephone.

1.3 In the event that an oiled ESA-listed marine mammal is spotted, the POA must report the incident within 24 hours to the Marine Mammal Stranding Hotline at 877-925-7773, and to NMFS Permits Division Jaclyn Daly 301-427-8438.

1.4 In the event that authorized take is exceeded, met, or likely to be met, the POA must contact the Assistant Regional Administrator, Protected Resources Division, NMFS, Juneau office at 907-586-7638, and/or by email to jon.kurland@noaa.gov, and NMFS Permitting Division at 301-427-8484, and email Jaclyn.daly@noaa.gov. NMFS AKR will work with NMFS Permit Division and USACE and the operator to determine what is necessary to minimize the likelihood of further take and determine if reinitiation of consultation is warranted (50 CFR 402.16).

1.5 The POA must evaluate the effects of pile driving noise and other in-water activities on beluga passage into or out of Knik Arm, submitting their analysis to NMFS AKR in an annual report (see T&C 1.6).

1.6 The POA must submit to NMFS AKR an annual report summarizing ESA-listed marine mammal sightings and annual takes of listed marine mammals. The annual report will be submitted within 90 days of the cessation of in-water work each year. The draft annual report will be subject to review and comment by NMFS AKR. Comments and recommendations made by NMFS AKR must be addressed in the annual report prior to NMFS acceptance of the annual report. The draft report will be considered final for the activities described in this opinion if NMFS AKR has not provided comments and recommendations within 30 days of receipt of the draft report. This annual report must contain the following information:

1.6.1 A description of the implementation and qualitative assessment of the effectiveness of mitigation measures for minimizing adverse effects of the action on ESA-listed species;

1.6.2 Lessons learned and recommendations for improvement of mitigation measures and monitoring techniques; and

1.6.3 A digital file that can be queried containing all observer monitoring data and associated metadata.

11. Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of 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 that the POA develop 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.

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 Port of Alaska should notify NMFS AKR of any conservation recommendations they implement.

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, the USACE, the POA, and the general public. These consultations help to fulfill multiple legal obligations of the named agencies. The information is also useful and of interest to the general public as it describes the manner in which public trust resources are being managed and conserved. The information presented in these documents and used in the underlying consultations represents the best available scientific and commercial information and has been improved through interaction with the consulting agency.

This consultation will be posted on the NMFS Alaska Region website http://alaskafisheries.noaa.gov/pr/biological-opinions/. The format and name adhere to conventional standards for style.

13.2. Integrity

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

13.3. Objectivity

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

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

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

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

14. References

61 North Environmental. 2021a. 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. 2021b. Port of Alaska Modernization Program Petroleum and Cement Terminal- 2021 Construction, Monthly Marine Mammal Monitoring Report for 31 May to 27 June 2021. Report prepared by 61 North Environmental for Pacific Pile and Marine, Port of Alaska, and National Marine Fisheries Service, 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, Final report prepared by ABR, Inc., for R & M Consultants, Inc. and the Port of Anchorage, Fairbanks, AK.

ABR. Inc. 2016. Protected Species Monitoring at the Kodiak Ferry Terminal and Dock Improvements Project, Kodiak, Alaska, 2015-2016. Prepared for R & M Consultants, Inc. and Alaska DOT., Fairbanks, AK.

ADEC. 2013. Alaska's final 2012 Integrated Water Quality Monitoring and Assessment Report. 161 pp.

ADEC. 2015. Annual Summary of Oil and Hazardous Substance Spills Fiscal Year 2014, Anchorage, Alaska.

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

ADFG. 2007. Management plan for invasive northern pike in Alaska. Pages 62 p *in*. Alaska Department of Fish and Game, Anchorage, AK.

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

Alaska Department of Natural Resources. 2020. Active Oil and Gas Lease Inventory. A. D. o. O. a. Gas, editor.

Alaska Journal of Commerce. 2009. Producers drain Drift River terminal, wait for Redoubt. Alaska Journal of Commerce (1).

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.

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(2):726-730.

Au, W. W. L., and coauthors. 2006. Acoustic properties of humpback whale songs. Journal of the Acoustical Society of America 120(2):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(6):2273-2275.

Bailey, H., and coauthors. 2010. Assessing underwater noise levels during pile-driving at an offshore windfarm and its potential effects on marine mammals. Marine Pollution Bulletin 60(6):888-897.

Baker, C. S. 1985. The population structure and social organization of humpback whales (*Megaptera novaeangliae*) in the central and eastern North Pacific. University of Hawaii.

Ballinger, T. J., and coauthors. 2020. Surface Air Temperature. In R. L. Thoman, J. Richter-Menge, and M. L. Druckenmiller, Eds. Arctic Report Card 2020. . Pages 21-27 *in*. NOAA.

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.

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.

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(C11007).

Becker, P. R., and coauthors. 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(3):81-98.

Becker, P. R., and coauthors. 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., and coauthors. 2015. Status review of the humpback whale (*Megaptera novaeangliae*) under the Endangered Species Act. N. Department of Commerce, NMFS, SWFSC, editor.

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

Blackwell, S. B., J. W. Lawson, and M. T. Williams. 2004. Tolerance by ringed seals (Phoca hispida) to impact pipe-driving and construction sounds at an oil production island. The Journal of the Acoustical Society of America 115(5):2346-2357.

Blane, J. M., and R. Jaakson. 1994. The impact of ecotourism boats on the St Lawrence beluga whales. Environmental Conservation 21(3):267-269.

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

BOEM. 2017. Final Biological Assessment Oil and Gas Activities Associated with Lease Sale 244. Cook Inlet Beluga, Fin Whale, Humpback Whale, Western Distinct Population Segment of the Steller Sea Lion, and Cook Inlet Beluga and Western Distinct Population Segment of the Steller Sea Lion Critical Habitat. Prepared by: CSA Ocean Sciences Inc. Received February 17, 2017. .

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(9):3414-3420.

Boyd, C., and coauthors. 2019. Bayesian estimation of group sizes for a coastal cetacean using aerial survey data. Marine Mammal Science 35(4):1322-1346.

Brandt, M. J., A. Diederichs, K. Betke, and G. Nehls. 2011. Responses of harbour porpoises to pile driving at the Horns Rev II offshore wind farm in the Danish North Sea. Marine Ecology Progress Series 421:205-216.

Brenner, R. E., S. J. Larsen, and A. R. C. Munro, A.M. 2021. Run Forecasts and Harvest Projections for 2021 Alaska Salmon Fisheries and Review of the 2020 Season. Pages 86 *in* D. o. S. F. a. C. F. Alaska Department of Fish and Game, editor.

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(1):99-113.

Bryant, M. 2009. Global climate change and potential effects on Pacific salmonids in freshwater ecosystems of southeast Alaska. Climatic Change 95(1):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(sp2).

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(2):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.

Calkins, D. G. 1989. Status of beluga whales in Cook Inlet. Pages 109-112 *in* 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. Alaska Dept. of Fish and Game. 76pp.

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(Supplement 1):212-222.

Carstensen, J., O. D. Henriksen, and J. Teilmann. 2006. Impacts of offshore wind farm construction on harbour porpoises: acoustic monitoring of echolocation activity using porpoise detectors (T-PODs). Marine Ecology Progress Series 321:295-308.

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(6):e39593.

Castellote, M., and coauthors. 2014. Baseline hearing abilities and variability in wild beluga whales (*Delphinapterus leucas*). Journal of Experimental Biology 217(10):1682-1691.

Castellote, M., and coauthors. 2020. Seasonal distribution and foraging occurrence of Cook Inlet beluga whales based on passive acoustic monitoring. Endangered Species Research 41:225-243.

Castellote, M., and coauthors. 2016a. Dual instrument passive acoustic monitoring of belugas in Cook Inlet, Alaska. Journal of the Acoustical Society of America 139(5):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.

Castellote, M., and coauthors. 2018. Anthropogenic Noise and the Endangered Cook Inlet Beluga Whale, Delphinapterus leucas: Acoustic Considerations for Management. Marine Fisheries Review 80(3):36-88.

Cavole, L. M., and coauthors. 2016. Biological impacts of the 2013–2015 warm-water anomaly in the Northeast Pacific: winners, losers, and the future. Oceanography 29(2):273-285.

CH2M, I. a. H. 2021. Port of Alaska Modernization Program Soth Floating Dock Project: Application for a Marine Mammal Protection Act Incidental Harassment Authorization, Anchorage, Alaska.

Chapin, F. S., III, and coauthors. 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., and coauthors. 2020. Record-Setting Ocean Warmth Continued in 2019. Advances in Atmospheric Sciences 37(2):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 *in*. IEEE.

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.

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

Clark, C. W., and W. T. Ellison. 2004. Potential use of low-frequency sounds by baleen whales for probing the environment: Evidence from models and empirical measurements. Pages 564-582 *in* J. A. Thomas, C. F. Moss, and M. Vater, editors. Echolocation in Bats and Dolphins. University of Chicago Press.

Clark, C. W., and coauthors. 2009. Acoustic masking in marine ecosystems: intuitions, analysis, and implication. Marine Ecology Progress Series 395:201-222.

Colbeck, G. J., and coauthors. 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(1752):20122552.

Cornick, L., D. S. Love, L. Pinney, C. Smith, and Z. Zartler. 2011. Distribution, Habitat Use and Behavior of Cook Inlet Beluga Whales and Other Marine Mammals at the Port of Anchorage Marine Terminal Redevelopment Project June – November 2011.

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

Cosens, S. E., and L. P. Dueck. 1988. Responses of migrating narwhal and beluga to icebreaker traffic at the Admiralty Inlet ice-edge, NWT in 1986. Port and ocean engineering under Arctic conditions 2:39-54.

Costa, D. P., and coauthors. 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(2):1155-1165.

Cowan, D., and B. Curry. 2008. Histopathology of the alarm reaction in small odontocetes. Journal of Comparative Pathology 139(1):24-33.

Cowan, D. F., and B. E. Curry. 2002. Histopathological assessment of dolphins necropsied onboard vessels in the eastern tropical pacific tuna fishery. National Marine Fisheries Service, Southwest Fisheries Science Center, NMFS SWFSC administrative report LJ-02-24C.

Curry, B. E., and E. F. Edwards. 1998. Investigation of the potential influence of fishery-induced stress on dolphins in the eastern tropical Pacific Ocean: Research planning. US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Dähne, M., and coauthors. 2013. Effects of pile-driving on harbour porpoises (Phocoena phocoena) at the first offshore wind farm in Germany. Environmental Research Letters 8(2):025002.

DeGrandpre, M., and coauthors. 2020. Changes in the Arctic Ocean Carbon Cycle With Diminishing Ice Cover. Geophysical Research Letters 47(12):e2020GL088051.

Delean, B. J., and coauthors. 2020. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks 2013-2017. Pages 86 p *in*. 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 prepared by JASCO Applied Sciences for Jacobs Engineering Group, Inc., for Furie Operating Alaska, Contract 05DK1602-S15-0005, Report P001256, Document 01243 Version 2.0, Anchorage, AK.

Doney, S. C., and coauthors. 2012. Climate change impacts on marine ecosystems. Annual Reviews in Marine Science 4:11-37.

Dueñas, M.-A., and coauthors. 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.

Dunker, K., and coauthors. 2020. A decade in review: Alaska's adaptive management of an invasive apex predator. Fishes 5(2):12.

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(1):430-437.

Edds-Walton, P. L. 1997. Acoustic communication signals of mysticete whales. Bioacoustics 8:47-60.

Eisner, L. B., and coauthors. 2020. Environmental impacts on walleye pollock (Gadus chalcogrammus) distribution across the Bering Sea shelf. Deep Sea Research Part II: Topical Studies in Oceanography:104881.

Eley, W. D. 2012. Cook Inlet vessel traffic study. Report to Cook Inlet Risk Assessment Advisory Panel. Cape International, Juneau, AK.

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(1):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. 2002. Underwater noise of whale-watching boats and potential effects on killer whales (*Orcinus orca*), based on an acoustic impact model. Marine Mammal Science 18(2):394-418.

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

Everitt, R., C. Fiscus, and R. DeLong. 1980. Northern Puget Sound marine mammals. Interagency energy/environment R&D Program Report. EPA 600/7-80-139. Prepared for the US EPA, Washington, DC.

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(4):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.

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(4):37-47.

Feely, R. A., and coauthors. 2004. Impact of anthropogenic CO2 on the CaCO3 system in the oceans. Science 305(5682):362-366.

Ferguson, M. C., C. Curtice, and J. Harrison. 2015. 6. Biologically Important Areas for Cetaceans Within US Waters-Gulf of Alaska Region. Aquatic Mammals 41(1):65.

Ferrero, R. C., S. E. Moore, and R. C. Hobbs. 2000. Development of beluga, Delphinapterus leucas, capture and satellite tagging protocol in Cook Inlet, Alaska. Marine Fisheries Review 62(3):112-123.

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., and coauthors. 2005. Pure tone audiograms and possible aminoglycoside-induced hearing loss in belugas (*Delphinapterus leucas*). Journal of the Acoustical Society of America 117(6):3936-3943.

Finneran, J. J., and C. E. Schlundt. 2013. Effects of fatiguing tone frequency on temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*). The Journal of the Acoustical Society of America 133(3):1819-1826.

Finneran, J. J., and coauthors. 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(1):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(1):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(6):2929-2940.

Fish, J. F., and J. S. Vania. 1971. Killer whale, Orcinus orca, sounds repel white whales, Delphinapterus leucas. Fishery Bulletin 69(3):531.

Forney, K. A., and coauthors. 2017. Nowhere to go: noise impact assessments for marine mammal populations with high site fidelity. Endangered Species Research 32:391-413.

Francis, C. D., and J. R. Barber. 2013. A framework for understanding noise impacts on wildlife: An urgent conservation priority. Frontiers in Ecology and the Environment 11(6):305-313.

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):1-16.

Fritz, L., K. Sweeney, R. Towell, and T. Gelatt. 2016. Aerial and Ship-Based Surveys of Steller Sea Lions (*Eumetopias jubatus*) Conducted in Alaska in june-July 2013 through 2015, and an Update on the Status and Trend of the Western Distinct Population Segment in Alaska. N. U.S. Dep. Commer., NMFS, editor. Alaska Fisheries Science Center, Seattle, WA.

Frölicher, T. L., E. M. Fischer, and N. Gruber. 2018. Marine heatwaves under global warming. Nature 560(7718):360-364.

Funk, D. W., T. M. Markowitz, and R. Rodrigues. 2005. Baseline studies of beluga whale habitat use in Knik Arm, Upper Cook Inlet, Alaska, July 2004-July 2005. Rep. from LGL Alaska Research Associates, Inc., Anchorage, AK, in association with HDR Alaska, Inc., Anchorage, AK, for the Knik Arm Bridge and Toll Authority, Anchorage, AK, the Department of Transportation and Public Facilities, Anchorage, AK, and the Federal Highway Administration, Juneau, AK.

Funk, D. W., R. Rodrigues, D. S. Ireland, and W. R. Koski. 2010. Summary and assessment of potential effects on marine mammals. Pages 11-1 - 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, volume LGL Alaska Report P1050-2.

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(1-3):75.

Gardiner, K. J., and A. J. Hall. 1997. Diel and annual variation in plasma cortisol concentrations among wild and captive harbor seals (*Phoca vitulina*). Canadian Journal of Zoology 75(11):1773-1780.

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(6):3054-3067.

Geraci, J. R. 1990. Physiologic and Toxic Effects on Cetaceans. Pages 167-197 *in* J. R. Geraci, and D. J. St. Aubin, editors. Sea Mammals and Oil: Confronting the Risks. Academic Press, Inc., and Harcourt Brace Jovanovich, San Diego, CA.

Geraci, J. R., and coauthors. 1989. Humpback whales (*Megaptera novaeangliae*) fatally poisoned by dinoflagellate toxin. Canadian Journal of Fisheries and Aquatic Sciences 46(11):1895-1898.

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*. 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(2):135-147.

Goldbogen, J. A., and coauthors. 2008. Foraging behavior of humpback whales: kinematic and respiratory patterns suggest a high cost for a lunge. Journal of Experimental Biology 211(23):3712-3719.

Grebmeier, J. M., and coauthors. 2006. A major ecosystem shift in the northern Bering Sea. Science 311(5766):1461-1464.

Haelters, J., W. Van Roy, L. Vigin, and S. Degraer. 2012. The effect of pile driving on harbour porpoises in Belgian waters. Offshore wind farms in the Belgian part of the North Sea. Heading for an understanding of environmental impacts. Royal Belgian Institute of Natural Sciences, Brussels:127-143.

Hain, J., R. Carter, D. Kraus, A. Mayo, and E. Winni. 1982. Feeding behavior of the humpback whale, *Megaptera novaeangliae*, in the western North Atlantic. Fishery Bulletin 80(2).

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(6):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.

Harrison, C. S., and J. D. Hall. 1978. Alaskan distribution of beluga whale, *Delphinapterus leucas*. Canadian Field-Naturalist 92(3):235-241.

Hastie, G. D., and coauthors. 2015. Sound exposure in harbour seals during the installation of an offshore wind farm: predictions of auditory damage. Journal of Applied Ecology 52(3):631-640.

HDR. 2015. Marine mammal monitoring report, Seward Highway MP 75-90 geotechnical activities, Turnagain Arm, Alaska, April 6-June 7, 2015.

HDR. 2021. Port of Alaska Modernization Program South Floating Dock Project: Biological Assessment. , Anchorage, Alaska.

Helweg, D. A., D. S. Houser, and P. W. Moore. 2000. An integrated approach to the creation of a humpback whale hearing model. SPACE AND NAVAL WARFARE SYSTEMS CENTER SAN DIEGO CA.

Herráez, P., and coauthors. 2007. Rhabdomyolysis and myoglobinuric nephrosis (capture

myopathy) in a striped dolphin. Journal of Wildlife Diseases 43(4):770-774.
Hinch, S. G., and coauthors. 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(2):576-99.
Hines, A. H., and G. M. Ruiz. 2000. Marine Invasive species and biodiversity of South Central Alaska. Smithsonian Environmental Research Center.
Hinzman, L. D., and coauthors. 2005. Evidence and Implications of Recent Climate Change in Northern Alaska and Other Arctic Regions. Climatic Change 72(3):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(4):331-340.
Hobbs, R. C., and K. E. W. Shelden. 2008. Supplemental status review and extinction assessment of Cook Inlet belugas (*Delphinapterus leucas*). National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center.
Hobbs, R. C., C. L. Sims, and K. E. W. Shelden. 2012. Estimated abundance of belugas in Cook Inlet, Alaska, from aerial surveys conducted in June 2012. Unpublished report. National Marine Fisheries Service, National Marine Mammals Laboratory.
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(1):EL27-EL32.
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(6):4090-4099.
Houser, D. S., D. A. Helweg, and P. W. Moore. 2001. A bandpass filter-bank model of auditory sensitivity in the humpback whale. Aquatic Mammals 27(2):82-91.
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.
Hunt, K. E., R. M. Rolland, S. D. Kraus, and S. K. Wasser. 2006. Analysis of fecal glucocorticoids in the North Atlantic right whale (*Eubalaena glacialis*). Gen Comp Endocrinol 148(2):260-272.
Huntington, H. P. 2000. Using traditional ecological knowledge in science: methods and applications. Ecological Applications 10(5):1270-1274.
Huntington, H. P., and coauthors. 2020. Evidence suggests potential transformation of the Pacific Arctic ecosystem is underway. Nature Climate Change 10(4):342-348.
ICRC. 2009. Marine Mammal Monitoring Final Report: 15 July 2008 though 14 July 2009. Construction and scientific monitoring associated with the Port of Anchorage Marine Terminal Redevelopment Project., Anchorage, AK.
ICRC. 2012. 2011 Annual Marine Mammal Monitoring Report. Construction and Scientific Monitoring Associated with the Port of Anchorage Intermodal Expansion Project, Marine Terminal Redevelopment. .

Illingworth & Rodkin, I. 2014. Anchorage Port modernization project, underwater noise monitoring plan. Prepared for CH2M Hill Engineers, Inc., Project No. 14-141. 43 pp.

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* D. C. R. H.- O. Pörtner, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, M. Nicolai, A. Okem, J. Petzold, B. Rama, N. Weyer, editor. IPCC Special Report on the Ocean and Cryosphere in a Changing Climate. Intergovernmental Panel on Climate Change.

Isaac, J. L. 2009. Effects of climate change on life history: implications for extinction risk in mammals. Endangered Species Research 7(2):115-123.

Jacobs Engineering. 2017a. 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. 2017b. Biological Evaluation for Offshore Oil and Gas Exploratory Drilling in the Kitchen Lights Unit of Cook Inlet, Alaska. Developed for Furie Operating Alaska, LLC. .

Jemison, L. A., and coauthors. 2013. Inter-population movements of Steller sea lions in Alaska with implications for population separation. PLoS One 8(8):e70167.

Jiang, L., and coauthors. 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(6):2651-4.

Johnson, J. H., and A. A. Wolman. 1984. The Humpback Whale, *Megaptera novaeangliae*. Marine Fisheries Review 46(4):300-337.

Joint Base Elmendorf-Richardson. 2010. Beluga Observational Studies on Eagle River Flats, Fort Richardson, Alaska 2009.

Jokela, B., and coauthors. 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., 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(3):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(2):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):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(10):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 (1):249-265.

Klishin, V., V. Popov, and A. Y. Supin. 2000. Hearing capabilities of a beluga whale, Delphinapterus leucas. Aquatic Mammals 26(3):212-228.

Koski, W. R., and coauthors. 2009. An update on feeding by bowhead whales near an offshore seismic survey in the central Beaufort Sea.

Krieger, K. J., and B. L. Wing. 1986. Hydroacoustic monitoring of prey to determine humpback whale movements.

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(1):22-36.

Lammers, M. O., and coauthors. 2013. Passive acoustic monitoring of Cook Inlet beluga whales (Delphinapterus leucas). Journal of the Acoustical Society of America 134(3):2497-2504.

Learmonth, J. A., and coauthors. 2006. Potential effects of climate change on marine mammals. Oceanography and Marine Biology: An Annual Review 44:431-464.

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(1):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(12):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(3):183-194.

LLC, T. 2016. Port MacKenzie Dock Emergency Repair - Matanuska-Susitna Borough, Marine Mammal Monitoring Summary for April 2016.

Lomac-MacNair, K., C. Thissen, and M.A. Smultea. 2014. Draft 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. Submitted to SAE, Prepared by Smultea Environmental Sciences, P.O. Box 256, Preston, WA 98050. December 2, 2014., Preston, WA.

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(2):32-39.

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.

Loughlin, T. R., D. J. Rugh, and C. H. Fiscus. 1984. Northern sea lion distribution and abundance: 1956-80. Journal of Wildlife Management 48(3):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(4):40-46.

Lüthi, D., and coauthors. 2008. High-resolution carbon dioxide concentration record 650,000–800,000 years before present. Nature 453(7193):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(2):125-136.

Manly, B. F. J. 2006. Incidental catch and interactions of marine mammals and birds in the Cook Inlet salmon driftnet and setnet fisheries, 1999-2000. Final Report to NMFS Alaska Region.

Marcogliese, D. J. 2001. Implications of climate change for parasitism of animals in the aquatic environment. Canadian Journal of Zoology 79(8):1331-1352.

Martins, E. G., and coauthors. 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(2):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(3):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(5):702-715.

McCauley, R. D., and coauthors. 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(1):638-642.

McGuire, T., M. Blees, and M. Bourdon. 2011. Photo-identification of beluga whales in upper Cook Inlet, Alaska. Final report of field activities and belugas resighted in 2009. Report prepared by LGL Alaska Research Associates, Inc., Anchorage, AK, for National Fish and Wildlife Foundation, Chevron, and ConocoPhillips Alaska. Inc.

McGuire, T., C. C. Kaplan, M. K. Blees, and M. R. Link. 2008. Photo-identification of beluga whales in Upper Cook Inlet, Alaska: 2007 Annual Report. Prepared for Chevron, National Fish and Wildlife Foundation, and ConocoPhillips Alaska, Inc. LGL Alaska Research Associates, Inc.

McGuire, T., and A. Stephens. 2016a. Photo-identification of beluga whales in Knik Arm and Turnagain Arm, Upper Cook Inlet, Alaska: Summary of field activities and whales identified in 2014. LGL Alaska Research Associates, Inc. for National Fish and Wildlife Foundation and National Marine Fisheries Service, Alaska Region., Anchorage, AK.

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. 2013. Photo-identification of Cook Inlet beluga whales in the waters of the Kenai Peninsula Borough, Alaska. Report prepared by LGL Alaska Research Associates, Inc., Anchorage, AK, for Department of Defense, U.S. Air Force, JBER, and the Alaska Department of Fish and Game. , Final report of field activities and belugas identified 2011-2013.

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., A. Stephens, and J. R. McClung. 2018. Photo-identification of beluga whales in Upper Cook Inlet, Alaska: summary of field activities and whales identified in 2017. Prepared by the Cook Inlet Beluga Whale Photo-ID Project for the National Marine Fisheries Service, Alaska Region, Anchorage, AK.

McGuire, T. L., and coauthors. 2020a. Patterns of mortality in endangered Cook Inlet beluga whales: Insights from pairing a long-term photo-identification study with stranding records. Marine Mammal Science 2020:1-20.

McGuire, T. L., and A. Stephens. 2016b. Summary Report: Status of previously satellite tagged Cook Inlet beluga whales. Report prepared by LGL Alaska Research Associates, Inc.,, Anchorage, AK.

McGuire, T. L., and coauthors. 2020b. Anthropogenic scarring in long-term photo-identification records of Cook Inlet beluga whales, *Delphinapterus leucas*. Marine Fisheries Review 82(3-4):20-40.

McQuinn, I. H., and coauthors. 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(6):3661-3673.

Melcon, M. L., and coauthors. 2012. Blue whales respond to anthropogenic noise. PLoS One 7(2):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(5):776-786.

Miller, G., and coauthors. 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.

Mohseni, O., and H. Stefan. 1999. Stream temperature/air temperature relationship: a physical interpretation. Journal of hydrology 218(3-4):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(9):485-492.

Mooney, T. A., and coauthors. 2008. Hearing pathways and directional sensitivity of the beluga whale, Delphinapterus leucas. Journal of Experimental Marine Biology and Ecology 362(2):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(3):60-80.

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(4):2692-2701.

Murray, N. K., and F. H. Fay. 1979. The white whales or belukhas, *Delphinapterus leucas*, of Cook Inlet, Alaska. International Whaling Commission Scientific Committee.

Muto, M., and coauthors. 2018. Alaska marine mammal stock assessments, 2017. NOAA Technical Memorandum NMFS-AFSC-378. Alaska Fisheries Science Center, Seattle, WA.

Muto, M. M., and coauthors. 2020. Alaska marine mammal stock assessments, 2019. Pages 395 p *in*. 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 *in* Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, California.

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: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.

Neuswanger, J. R., M. S. Wipfli, M. J. Evenson, N. F. Hughes, and A. E. Rosenberger. 2015. Low productivity of Chinook salmon strongly correlates with high summer stream discharge in two Alaskan rivers in the Yukon drainage. Canadian Journal of Fisheries and Aquatic Sciences 72(8):1125-1137.

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* D. o. C. NOAA, editor. U.S. government, Federal Register.

NMFS. 2008a. Final Conservation Plan for the Cook Inlet beluga whale (*Delphinapterus leucas*). N. Department of Commerce, editor, Anchorage, AK.

NMFS. 2008b. Recovery plan for the Steller sea lion (Eumetopias jubatus). Revision. U. S. DOC/NOAA/NMFS, editor, Silver Spring, Maryland.

NMFS. 2010. 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. A. R. National Marine Fisheries Service, editor, Juneau, AK.

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. . A. R. National Marine Fisheries Service, editor, Anchorage, AK.

NMFS. 2016b. Recovery Plan for the Cook Inlet Beluga Whale (*Delphinapterus leucas*). 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. Letter of Concurrence for barge dock repair, Port MacKenzie, Matanuska-Susitna Borough, POA-1979-412, Upper Cook Inlet. May 15, 2017. N. Department of Commerce, NMFS, Protected Resources Division, Alaska Region, editor, Anchorage, AK.
NMFS. 2018a. 2018 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. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59.
NMFS. 2018b. 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. N. Department of Commerce, editor, Anchorage, AK.
NMFS. 2018c. 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. 2020. Endangered Species Act Section 7 Consultation Biological Opinion on the Port of Alaska's Petroleum and Cement Terminal, Anchorage, Alaska. Pages 195 p *in*. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fishereis Service, Alaska Regional Office, Anchorage, AK.
Noad, M. J., and D. H. Cato. 2007. Swimming speeds of singing and non-singing humpback whales during migration. Marine Mammal Science 23(3):481-495.
Norberg, B. 2000. Looking at the effects of acoustic deterrent devices on California seal lion predation patterns at a commercial salmon farm. NMFS, F/NWR2.
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(1):e02955.
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., and coauthors. 2015. Marine seismic surveys and ocean noise: time for coordinated and prudent planning. Frontiers in Ecology and the Environment 13(7):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(2):81-115.
NRC. 2003. Ocean Noise and Marine Mammals. National Academy Press, Washington, D.C.
Nuka Research and Planning and Pearson Consulting LLC. 2015. Cook Inlet Risk Assessment Final Report.
Orr, J. C., and coauthors. 2005. Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. Nature 437:681-686.
Overland, J. E., and coauthors. 2017. Arctic Report Card 2017.
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.

Owl Ridge. 2014. Cosmopolitan State 2013 Drilling Program Marine Mammal Monitoring and Mitigation 90-day Report. Prepared by Owl Ridge Natural Resource Consultants for BlueCrest Alaska Operating LLC, Anchorage, AK.

Patenaude, N. J., and coauthors. 2002. Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the Alaskan Beaufort Sea. Marine Mammal Science 18(2):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(2):89-114.

Peterson, W., N. Bond, and M. Robert. 2016. The blob (part three): Going, going, gone? PICES Press 24(1):46.

Pirotta, E., N. D. Merchant, P. M. Thompson, T. R. Barton, and D. Lusseau. 2015. Quantifying the effect of boat disturbance on bottlenose dolphin foraging activity. Biological Conservation 181:82-89.

Pitcher, K. W., and D. G. Calkins. 1981. Reproductive biology of Steller sea lions in the Gulf of Alaska. Journal of Mammalogy 62(3):599-605.

Pitcher, K. W., and F. H. Fay. 1982. Feeding by Steller sea lions on harbor seals.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., and coauthors. 2019. Intestinal polycyclic aromatic hydrocarbon-DNA adducts in a population of beluga whales with high levels of gastrointestinal cancers. Environmental and molecular mutagenesis 60(1):29-41.

Popper, A. N., and M. C. Hastings. 2009. The effects of human-generated sound on fish. Integrative Zoology 4(1):43-52.

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(5):692-713.

Qi, D., and coauthors. 2017. Increase in acidifying water in the western Arctic Ocean. Nature Climate Change 7(3):195-199.

Quakenbush, L., and coauthors. 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(10):1487-1495.

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.

Reyff, J., C. Janello, and C. Heyvaert. 2021. Hydroacoustic Monitoring Report, Port of Alaska Modernization Program Petroleum and Cement Terminal Phase January 2021, Cotati, CA.

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. 1995a. Marine mammals and noise. Academic Press, Inc., San Diego, CA.
Richardson, W. J., C. R. Greene Jr, C. I. Malme, and D. H. Thomson. 1995b. Marine mammals and noise. Academic press.
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(4):1117-1128.
Ridgway, S. H., and coauthors. 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(22):3829-3841.
Rigzone. 2012. Apache Deploying Wireless Seismic Technology in Alaska's Cook Inlet.
Robertson, T. L., and L. Crews. 2003. Gross estimate of ballast water discharges into Cook Inlet, Alaska. Cook Inlet Regional Citizen's Council.
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., and coauthors. 2012. Evidence that ship noise increases stress in right whales. Proceedings of the Royal Society B: Biological Sciences 279(1737):2363-2368.
Romano, T., and coauthors. 2004. Anthropogenic sound and marine mammal health: measures of the nervous and immune systems before and after intense sound exposure. Canadian Journal of Fisheries and Aquatic Sciences 61(7):1124-1134.
Romero, L. M., C. J. Meister, N. E. Cyr, G. Kenagy, and J. C. Wingfield. 2008. Seasonal glucocorticoid responses to capture in wild free-living mammals. American Journal of Physiology-Regulatory, Integrative and Comparative Physiology 294(2):R614-R622.
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(3):6-21.
Rugh, D. J., and coauthors. 2005. Aerial surveys of beluga in Cook Inlet, Alaska, June 2001, 2002, 2003, and 2004. Pages 71 p *in*. 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(1):69-75.
Ruiz, G. M., and coauthors. 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. Mote Marine Laboratory, Technical Report Number 1761.
Scheifele, P. M., and coauthors. 2005. Indication of a Lombard vocal response in the St. Lawrence River beluga. The Journal of the Acoustical Society of America 117(3):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.
Schindler, D. E., J. B. Armstrong, and T. E. Reed. 2015. The portfolio concept in ecology and

evolution. Frontiers in Ecology and the Environment 13(5):257-263.

Schindler, D. E., and coauthors. 2010. Population diversity and the portfolio effect in an exploited species. Nature 465(7298):609-612.

Sepulveda, A. J., D. S. Rutz, A. W. Dupuis, P. A. Shields, and K. J. Dunker. 2015. Introduced northern pike consumption of salmonids in Southcentral Alaska. Ecology of Freshwater Fish 24(4):519-531.

Serreze, M. C., and R. G. Barry. 2011. Processes and impacts of Arctic amplification: a research synthesis. Global and Planetary Change 77(1):85-96.

Shanley, C. S., and D. M. Albert. 2014. Climate change sensitivity index for Pacific salmon habitat in Southeast Alaska. PloS one 9(8):e104799.

Shelden, K. E., and coauthors. 2018. Beluga whale, Delphinapterus leucas, satellite-tagging and health assessments in Cook Inlet, Alaska, 1999 to 2002.

Shelden, K. E., and coauthors. 2019. 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:1-9.

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. Pages 55 p *in*. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Shelden, K. E. W., and coauthors. 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(2):1-32.

Shelden, K. E. W., and coauthors. 2017. Aerial surveys, abundance, and distribution of beluga whales (Delphinapterus leucas) in Cook Inlet, Alaska, June 2016. Pages 62 p *in*. U. S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Shelden, K. E. W., and coauthors. 2013. Aerial surveys of beluga whales, *Delphinapterus leucas*, in Cook Inlet, Alaska, June 2005 to 2012. Pages 131 p *in*. U. S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

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(3):529-544.

Shelden, K. E. W., and P. R. Wade. 2019. Aerial surveys, distribution, abundance, and trend of belugas (Delphinapterus leucase) in Cook Inlet, Alaska, June 2018. AFSC Processed Rep. 2019-09, 93 p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle WA 98115.

Shields, P., and A. Dupuis. 2017. Upper Cook Inlet Commercial Fisheries Annual Management Report, 2016. Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries, Fishery Management Report No. 17-05, Anchorage, AK.

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(21):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(12):2824-2831.
Slabbekoorn, H., and coauthors. 2010. A noisy spring: the impact of globally rising underwater sound levels on fish. Trends in ecology & evolution 25(7):419-427.
Small, R. J., B. Brost, M. Hooten, M. Castellote, and J. Mondragon. 2017. Potential for spatial displacement of Cook Inlet beluga whales by anthropogenic noise in critical habitat. Endangered Species Research 32:43-57.
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., and coauthors. 2009. Addressing the effects of human-generated sound on marine life: an integrated research plan for US federal agencies. Interagency Task Force on Anthropogenic Sound and the Marine Environment of the Joint Subcommittee on Ocean Science and Technology, Washington, DC 72pp.
Southall, B. L., and coauthors. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals 33(4):411-521.
Spalding, D. J. 1964. Comparative feeding habits of the fur seal, sea lion and harbor seal on the British Columbia coast.
St. Aubin, D., S. H. Ridgway, R. Wells, and H. Rhinehart. 1996. Dolphin thyroid and adrenal hormones: circulating levels in wild and semidomesticated *Tursiops truncatus*, and influence of sex, age, and season. Marine Mammal Science 12(1):1-13.
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.
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., and coauthors. 2012. An Asian elephant imitates human speech. Current Biology 22(22):2144-2148.
Stroeve, J., M. M. Holland, W. Meier, T. Scambos, and M. Serreze. 2007. Arctic sea ice decline: Faster than forecast. Geophysical Research Letters 34(9).
Stroeve, J., and D. Notz. 2018. Changing state of Arctic sea ice across all seasons. Environmental Research Letters 13(10):103001.
Suryan, R. M., and coauthors. 2021. Ecosystem response persists after a prolonged marine heatwave. Scientific reports 11(1):1-17.
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, 29 November 2017.
Sweeney, K., R. Towell, and T. Gelatt. 2018. Results of Steller Sea Lion Surveys in Alaska, June-July 2018. N. Department of Commerce, NMFS, AFSC, MML, editor, Seattle, WA.
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.

Thomas, J. A., R. A. Kastelein, and F. T. Awbrey. 1990. Behavior and blood catecholamines of captive belugas during playbacks of noise from an oil drilling platform. Zoo Biology 9(5):393-402.

Tomilin, A. 1967. Mammals of the USSR and adjacent countries. Cetacea 9:666-696.

Tougaard, J., J. Carstensen, J. Teilmann, H. Skov, and P. Rasmussen. 2009. Pile driving zone of responsiveness extends beyond 20 km for harbor porpoises (Phocoena phocoena (L.)). The Journal of the Acoustical Society of America 126(1):11-14.

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.

U.S. Navy. 2015. Proxy source sound levels and potential bubble curtain attenuation for acoustic modeling of nearshore marine pile driving at Navy installations in Puget Sound. Prepared by Michael Slater, Naval Surface Warfare Center, Carderock Division, and Sharon Rainsberry, Naval Facilities Engineering Command Northwest, Silverdale, WA. January 2015.

URS, Corp. 2007. Port of Anchorage marine terminal development project underwater noise survey test pile driving program. Prepared by Integrated Concepts & Research Corporation.

USACE-DOER. 2001. Characterization of Underwater Sounds produced by Bucket Dredging Operations. .

USACE. 2008. Environmental assessment and finding of no significant impact: Anchorage Harbor dredging and disposal. 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.

von Biela, V. R., and coauthors. 2020. Evidence of prevalent heat stress in Yukon River Chinook salmon. Canadian Journal of Fisheries and Aquatic Sciences 77(12):1878-1892.

Vos, D. J., K. E. Shelden, N. A. Friday, and B. A. Mahoney. 2019. Age and growth analyses for the endangered belugas in Cook Inlet, Alaska.

Vos, D. J., and K. E. W. Shelden. 2005. Unusual mortality in the depleted Cook Inlet beluga (*Delphinapterus leucas*) population. Northwestern Naturalist 86(2):59-65.

Wade, P. R., and coauthors. 2016. Estimates of abundance and migratory destination for North Pacific humpback whales in both summer feeding areas and winter mating and calving areas. Paper SC/66b/IA21 submitted to the Scientific Committee of the International Whaling Commission, June 2016, Bled, Slovenia. Pages 42 p. *in*. International Whaling Commission.

Wang, Z., and coauthors. 2014. Assessing the underwater acoustics of the world's largest vibration hammer (OCTA-KONG) and its potential effects on the Indo-Pacific humpbacked dolphin (Sousa chinensis). PLoS One 9(10):e110590.

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(3):632-640.

Wartzok, D., and D. R. Ketten. 1999. Marine mammal sensory systems. Biology of marine mammals 1:117.

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(4):6-15.

Wasser, S. K., and coauthors. 2017. Population growth is limited by nutritional impacts on pregnancy success in endangered Southern Resident killer whales (Orcinus orca). PloS one 12(6):e0179824.

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(19):10296-10304.

Wieting, D. 2016. Interim Guidance on the Endangered Species Act Term "Harass". National Marine Fisheries Service, Office of Protected Resources. Silver Spring, MD. October 21, 2016.

Wiggin, M. 2017. Alaska's Oil and Gas Industry: Overview and Activity Update, Commonwealth North. Alaska Department of Natural Resources.

Williams, R., and E. Ashe. 2006. Northern resident killer whale responses to vessels varied with number of boats. NMFS Contract AB133F04SE0736.(Available from R. Williams, Pearse Island, Box 193, Alert Bay, BC V0N1A0, or E. Ashe, 2103 N. 54th St., Seattle, WA 98103.).

Williams, R., D. E. Bain, J. K. B. Ford, and A. W. Trites. 2002. Behavioural responses of male killer whales to a 'leapfrogging' vessel. Journal of Cetacean Research and Management 4(3):305-310.

Williams, R., and D. P. Noren. 2009. Swimming speed, respiration rate, and estimated cost of transport in adult killer whales. Marine Mammal Science 25(2):327-350.

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., and coauthors. 2007. Anthropogenic noise as a stressor in animals: a multidisciplinary perspective. International Journal of Comparative Psychology 20(2).

Wright, S., and K. Savage. 2016. 2016 Copper River Delta Carcass Surveys, Annual Report. National Marine Fisheries Service, Alaska Region Protected Resources Division, Juneau, AK.

Wright, S., and K. Savage. 2021. 2019 Copper River Delta Carass Surveys. NMFS Protected Resources Division.

Würsig, B., C. R. Greene Jr, and T. A. Jefferson. 2000. Development of an air bubble curtain to reduce underwater noise of percussive piling. Marine Environmental Research 49(1):79-93.

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(6):2365-2375.

Zimmermann, M., and M. Prescott. 2014. Smooth Sheet Bathymetry of Cook Inlet, Alaska.