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

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

Port of Nome Modification Project, POA-2022-00341, Nome, Alaska

NMFS Consultation Number: AKRO-2022-03034

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

Affected Species and Critical Habitat 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?
Bowhead Whale	Endangered	Yes	None Designated	No	N/A
Ringed Seal, Arctic Subspecies (*Phoca hispida hispida*)	Threatened	Yes	No	No	No
Bearded Seal, Beringia DPS (*Erignathus barbatus nauticus*)	Threatened	Yes	No	No	No
Steller Sea Lion, Western DPS (*Eumetopias jubatus)*	Endangered	Yes	No	No	No
North Pacific Right Whale (*Eubalaena japonica*)	Endangered	No	No	No	No
Humpback Whale, Western North Pacific DPS (*Megaptera novaeangliae*)	Endangered	No	No	No	No
Humpback Whale, Mexico DPS (*Megaptera novaeangliae*)	Threatened	No	No	No	No

Fin whale (*Balaenoptera physalus*)	Endangered	No	None Designated	No	N/A
Gray Whale, Western North Pacific DPS (*Eschrichtius robustus*)	Endangered	No	None Designated	No	N/A
Cook Inlet Beluga Whale (*Delphinapterus leucas)*	Endangered	No	No	No	No

Consultation Conducted By: National Marine Fisheries Service, Alaska Region

Issued By: ____________________
Jonathan M. Kurland
Regional Administrator

Date: July 27, 2023

Accessibility of this Document

Every effort has been made to make this document accessible to individuals of all abilities and compliant with Section 508 of the Rehabilitation Act. The complexity of this document may make access difficult for some. If you encounter information that you cannot access or use, please email us at Alaska.webmaster@noaa.gov or call us at 907-586-7236 so that we may assist you.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

TERMS AND ABBREVIATIONS

µPa	Micro Pascal
Ac	Acre
ACIA	Arctic Climate Impact Assessment
ADNR	Alaska Department of Natural Resources
AEWC	Alaska Eskimo Whaling Commission
AKR or AKRO	Alaska Region or Alaska Regional Office
ASAMM	Aerial Surveys of Arctic Marine Mammals
ASL	Above Sea Level
ASLC	Alaska SeaLife Center
BA	Biological Assessment
BSAI	Bering Sea/Aleutian Island
CI	Confidence Interval
CPUE	Catch Per Unit Effort
CSEL	Cumulative Sound Exposure Level
CV	Coefficient of Variance
CWA	Clean Water Act
dB re 1µPa	Decibel referenced 1 microPascal
DPS	Distinct Population Segment
EEZ	Exclusive Economic Zone
EPA	Environmental Protection Agency
ESA	Endangered Species Act
°F	Fahrenheit
FR	Federal Register
ft	Feet
Hz	Hertz
IHA	Incidental Harassment Authorization
IPCC	Intergovernmental Panel on Climate Change
ITA	Incidental Take Authorization
ITS	Incidental Take Statement
IWC	International Whaling Commission
kHz	Kilohertz
km	Kilometers
kn	Knots
m	Meter

mi	Mile
MMPA	Marine Mammal Protection Act
ms	Milliseconds
µPa	Micro Pascal
NEPA	National Environmental Policy Act
nm	Nautical mile
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NRC	National Research Council
NSB	North Slope Borough
NSF	National Science Foundation
NSR	Northern Sea Route
OC	Organochlorine
OCSP	Open Cell Sheet Pile
Pa	Pascals
PAH	Polycyclic aromatic hydrocarbons
PBF	Physical or biological features
PCB	Polychlorinated biphenyls
PCE	Primary constituent element
PSO	Protected Species Observer
PTS	Permanent Threshold Shift
RMS	Root Mean Square
RPA	Reasonable and Prudent Alternative
s	Second
SEL	Sound Exposure Level
SPCC	Spill Prevention, Control, and Countermeasure
TL	Transmission Loss
TTS	Temporary Threshold Shift
USACE	U.S. Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USCG	United States Coast Guard
yds	Yards

1 INTRODUCTION

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

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, NMFS and/or USFWS provide an opinion stating how the Federal agency's action is likely to affect ESA-listed species and their critical habitat. If incidental take is reasonably certain to occur, section 7(b)(4) requires the consulting agency to provide an incidental take statement (ITS) that specifies the impact of any incidental taking, specifies those reasonable and prudent measures necessary or appropriate to minimize such impact, and sets forth terms and conditions to implement those measures.

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

In this document, the action agencies are the U.S. Army Corps of Engineers, Alaska District, Regulatory Division (USACE), which proposes to modify Nome harbor, and the NMFS Office of Protected Resources, Permits and Conservation Division (hereafter referred to as "the Permits Division"), which proposes to issue incidental harassment authorizations (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 USACE for harassment of marine mammals incidental to the proposed action. The consulting agency for this proposal is NMFS 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 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.

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

1.1 Background

This opinion is based on information provided in the Port of Nome Modification Project Biological Assessment (BA) (USACE 2023) and the proposed IHA application for the same action. A complete record of this consultation is on file at NMFS Alaska Region office.

The proposed action involves the enlargement and improvement of the harbor in Nome, Alaska (Figure 1 and Figure 2), to increase vessel capacity and ability of large vessels to maneuver, and to alleviate congestion at existing port facilities.

This opinion considers the effects of disturbance resulting from removing a portion of the existing rubble-mound causeway, extending the causeway in an "L" shape, installing sheet piles and fender piles for new docks, and dredging the new and existing basins. In addition, the effects of project-specific vessel traffic between Anchorage and Nome for the delivery of supplies and equipment is also considered. These actions have the potential to affect the endangered bowhead whale (*Balaena mysticetus*), endangered fin whale (*Balaenoptera physalus*), endangered North Pacific right whale (*Eubalaena japonica*), endangered Western North Pacific distinct population segment (DPS) humpback whale (*Megaptera novaeangliae*), threatened Mexico DPS humpback whale (*Megaptera novaeangliae*), endangered Western North Pacific DPS gray whale (*Eschrichtius robustus*), threatened Arctic subspecies of ringed seal (*Phoca hispida hispida*), threatened Beringia DPS bearded seal (*Erignathus barbatus nauticus*), endangered Western DPS Steller sea lion (*Eumetopias jubatus*), endangered Cook Inlet beluga whale (*Delphinapterus leucas)*, and critical habitat for ringed and bearded seals, Steller sea lions, Western North Pacific and Mexico DPS humpback whales, North Pacific right whales, and Cook Inlet beluga whales.

Figure 1. Aerial Overview of Port of Nome on Norton Sound, Bering Sea, Alaska.

Figure 2. Artist's rendition of finished Port of Nome.

1.2 Consultation History

On August 24, 2022, NMFS Alaska Region received a letter from the USACE, formally designating Owl Ridge Natural Resource Consultants, Inc. (hereafter referred to as Owl Ridge) as their non-Federal representative for the preparation of a BA regarding this proposed action. At that time, the USACE requested informal section 7 consultation. On November 20, 2022, NMFS Alaska Region received a request for formal ESA section 7 consultation for the Port of Nome Modification Project and a BA. On February 14, 2023, NMFS Alaska Region received a revised BA. On March 22, 2023, NMFS Alaska Region received a change to the proposed action, which included additions to the mitigation measures. On May 1, 2023, NMFS Alaska Region received a request to initiate formal section 7 consultation for the IHA proposed by the Permit Division for the Port of Nome Modification Project. On May 3, 2023, NMFS Alaska Region informed USACE and the Permit Division that the BA was sufficient for initiating formal consultation, and initiated consultation on that date. On June 22, 2023, NMFS received an email from USACE indicating that they were changing their determinations for two species. Western North Pacific gray whale was changed from a likely to adversely affect determination to a not likely to adversely affect and bowhead whale was changed from a no effect to likely to adversely affect determination.

2 DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA

2.1 Proposed Action

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

This opinion considers the effects of the USACE's modification of Port of Nome. The proposed project is expected to extend across 7 open water seasons (approximately May through October) in two phases (Table 1).

- Phase 1 will require 4 open water seasons to complete, and includes:
  1) Removal of the breakwater spur off the existing west causeway and constructing a 3,500-foot L-shaped extension, forming a new basin beyond the existing Outer Harbor.
  2) Constructing a new, approximately 2,030-foot long, 'L' shaped continuous dock, along the basin side of the causeway extension.
- Phase 2 will require 3 open water seasons to complete, and will include:
  1) Dredging the new basin to a design depth of 40 feet (ft) below Mean Lower Low Water (MLLW) to create a Deep-Water Basin.
  2) Dredging the existing portions of the Outer Harbor to a new design depth of 28 ft below MLLW.

The USACE indicates that increased vessel traffic in the Arctic, coupled with limited marine infrastructure in the Nome region, results in operational inefficiencies, vessel damage, and decreased safety at the Port (USACE 2023). Increased costs and delays of goods and services threatens the long-term viability of surrounding communities. A safe, reliable, and efficient transportation hub at Nome is foundational to the long-term viability of communities in the region (USACE 2023).

Table 1. Details of construction activities by Phase.

Phase	Construction Activity	Notes
1	Mobilize	Vessel transit to/from Anchorage or other staging location
1	Remove breakwater spur	Removal of the existing west causeway spur
1	Dredge west causeway to -10 ft	To accommodate armor stone installation. Dredged material will be transported to an upland site (USACE 2022)
1	Place stones for new causeway	This work will begin in 2024. Rock causeway will provide protection from ocean currents/swell for sheet pile installation
1	Install temporary template piles	For template structures and barge support
1	Install dock using Open Cell Sheet Piles (OCSP)	Includes driving sheet and anchor H piles, placing fill within the cell to grade, and compaction of fill.
1	Remove temporary template piles	All temporary template piles will be removed before the end of construction season
1	Install fender and bollard piles	The fender piles will be installed after the sheet piles. The bollard piles are installed in the dry, on dock surface.
1	Install dock appurtenances and utilities	All in the dry
2	Dredge new Deep-Water Basin and existing portions of the Outer Harbor (Figure 3)	Dredge to a design depth of 40 ft below MLLW to create a Deep-Water Basin and dredge existing portions of the Outer Harbor to a new design depth of 28ft below MLLW. Dredged materials expected to be deposited in designated ocean site.

The USACE is utilizing various Federal authorities to accomplish this proposed action:

1. Funding will be received through the Energy and Water Development and Related Agencies Appropriations Act, 2021 (Division D of the Consolidated Appropriations Act, 2021, P.L. 116-260), used to initiate design of navigation improvements at the Port of Nome;
2. Construction will be authorized by the USACE by Section 401 of the Water Resources Development Act of 2020 (Division AA of the Consolidated Appropriation Act, 2021, P.L. 116-260);
3. Cost-sharing for this project is provided by Section 8312 of the Water Resources

Development Act of 2022 (WRDA 2022).

The Permits Division will issue an IHA for take of marine mammals by harassment under the MMPA incidental to these actions. The proposed IHA will cover the first open water season only when one third of Phase 1 construction will occur. Although we are considering the effects of all project activities for Phase 1 and Phase 2, because the IHA is valid for only one year, the Permit Division will need to reinitiate consultation for the second and third years of Phase 1 activities.

2.1.1 Proposed Activities

The Port of Nome expansion will:

1. Remove the existing breakwater spur;
2. Extend the existing rock causeway by approximately 3,500 ft in an L-shape (Figure 2 and Figure 3);
    a. The new causeway will be constructed similarly to the existing causeway and east breakwater with large armor stone placed in layers to resist waves and ice. Armor stone on the exterior (non-harbor) side of the causeway will have base layers placed below the existing mudline, requiring dredging of the seafloor to minus 10 feet.
3. Add approximately 2,030 ft of additional sheet pile dock face and 63 fender piles;
    a. The new dock will be constructed using an Open Cell Sheet Pile™ system (OCSP) that consists of a bulkhead with flexible walls constructed of steel sheet pile with embedded tail wall diaphragms supported by the substrate, similar in design to the three sheet pile docks located in the existing harbor.
4. Create a new deep water basin (Figure 3).

2.1.1.1 Vessel Transit

Project materials will be transported to Nome via barge, likely from Anchorage, following the most traveled direct route through Cook Inlet and Unimak Pass (Figure 4). Approximately 25 roundtrip transits between Anchorage and Nome are expected for the entirety of the project. Fill material for the sheet piles will likely come from the Cape Nome quarry (Figure 5). Up to 250 vessel round trips with a rock barge pulled by tug will occur during open water seasons to transport gravel and rock.

2.1.1.2 Dredging

Dredging will occur across both Phases 1 and 2, during daylight hours. It is unknown if the dredger will be a clam shell or suction dredger. The quantity of material (in cubic yards (CY)) to be dredged varies with location (Figure 3):

- West Causeway footprint dredged to 10 ft below the existing grade ~ 120,000 CY
- Outer Harbor dredged to about -28 ft below MLLW ~ 2,015,800 CY
- Deep Water Basin dredged to about -40ft below MLLW ~ 517,600 CY

The chemical characterization of all dredged material will be assessed prior to being transported to predesignated, approved sites for placement.

Previous sampling and chemical analyses of surface sediments in the Inner Harbor did not indicate significant, human-caused chemical contamination (e.g., petroleum hydrocarbons). However, high concentrations of up to 200 milligrams/kilogram (mg/kg) of arsenic regularly occurred in samples from the Inner Harbor (USACE 2012).

2.1.1.3 Construction

Construction of the sheet pile dock using OCSP cells will occur during Phase 1 and may take up to 3 open water seasons to complete. A portion of the causeway must be constructed before sheet pile installation begins. The rock causeway will provide protection from currents and ocean swells as the sheet piles are placed and installed. The rock causeway will also provide a barrier to sound that otherwise would travel in open water to the west. In a similar project at Kotzebue, vibratory sheet pile installation took 1-2 minutes per sheet (PND 2021b). Bollard piles and high mast piles will be installed on the dock (in the dry) and will not be considered further in this opinion.

OCSP cells are constructed using sheet piles and anchor piles. Once the piles for a cell have been installed, the cell is filled with gravel. This process continues sequentially until all the sheet pile cells are installed and backfilled. Piles will be driven using a vibratory hammer (APE 200-6 or comparable model). An impact hammer may be used if the vibratory hammer is not effective.

Table 2 is a summary of the duration of pile driving by pile type and methods of installation and removal during each construction season of Phase 1. Temporary pile type in *italics* are considered contingency pile types for template construction. Only one type of template pile will be used, not both. Vibratory methods will be used to remove template piles.

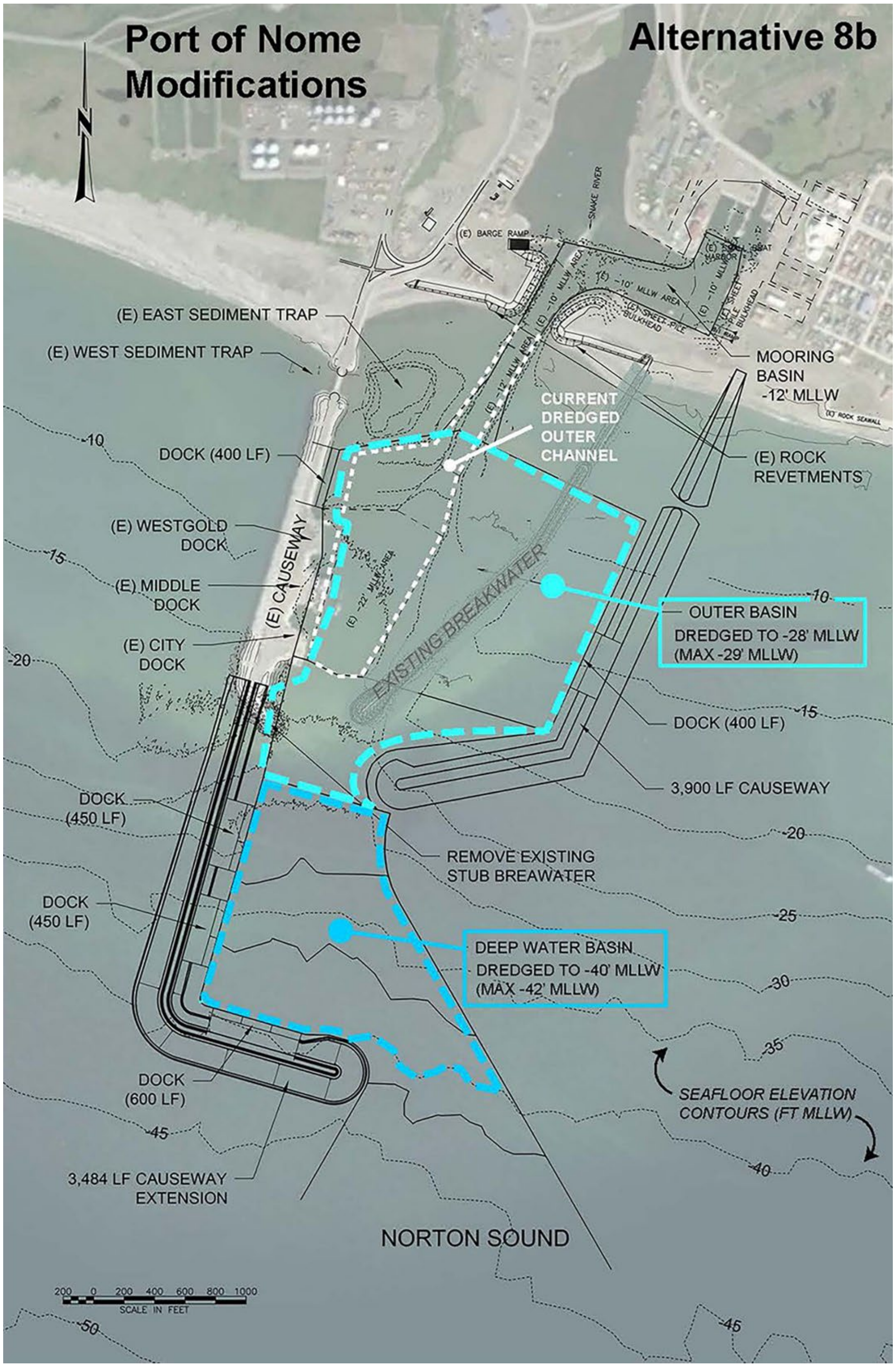

Figure 3. Port of Nome modification plans (USACE 2023).

Figure 4. Transit route between Anchorage and Nome.

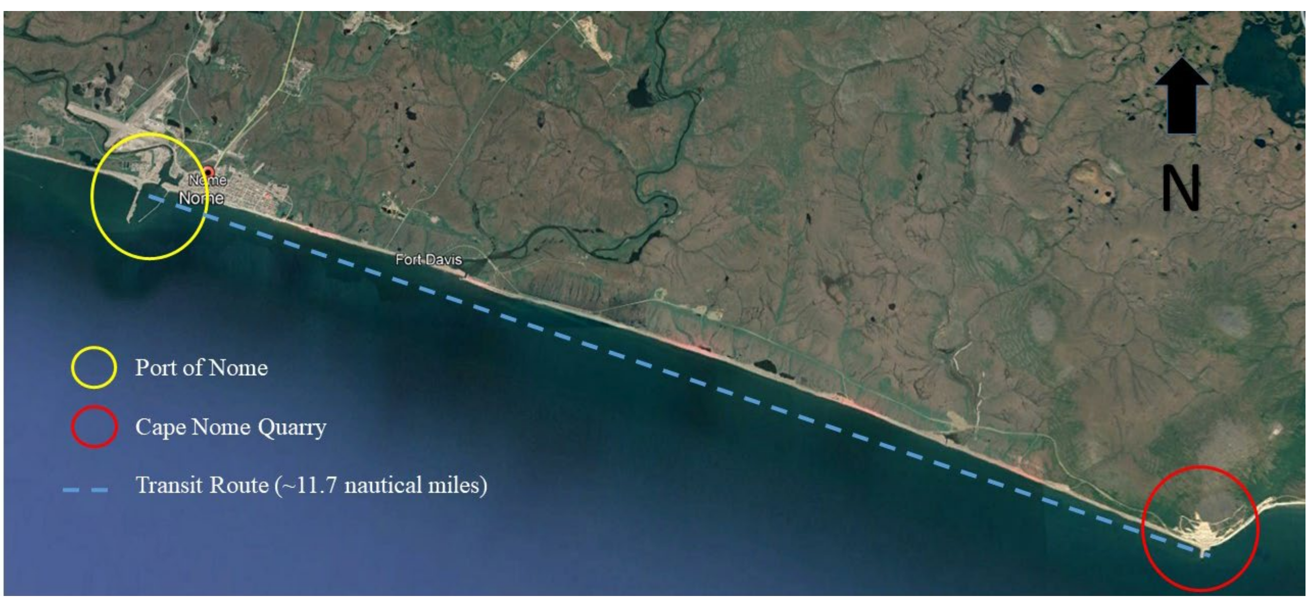

Figure 5. Transit route between Port of Nome and Cape Nome Quarry.

Table 2. Pile numbers by type and number of days during each season of Phase 1.

Driving Method-Pile Type	**Phase 1-Season 1**		**Phase 1-Season 2**		**Phase 1-Season 3**	
	Number of Piles	**Number of Days**	**Number of Piles**	**Number of Days**	**Number of Piles**	**Number of Days**
Temporary template piles -24" pipe, Installation	288	12	288	12	288	12
Temporary template piles -24" pipe, Removal	288	12	288	12	288	12
Temporary template piles - 14" H, Installation	288	12	288	12	288	12
Temporary template piles - 14" H, Removal	288	12	288	12	288	12
Anchor piles-14", Installation	27	2	27	2	27	2
Sheet piles-20", Installation	1,600	57	1,600	57	1,600	57
Fender piles-36" pipe, Installation	21	2	21	2	21	2

Temporary Template Piles

Prior to the construction of the OCSP dock, a temporary template will be constructed using 24-inch (") or smaller steel pipe pile or 14" H-piles. The piles will be driven in using a vibratory pile driver, and they will be removed following the completion of each OCSP cell using vibratory extraction methods. Twenty temporary template piles will be driven in 4 hours per day over 33 days of installation in Phase 1.

Anchor Piles

At the end of each sheet pile tail-wall, 14” H-shaped anchor piles with welded connectors will be installed. Twenty anchor piles will be driven. Each anchor pile takes approximately 4 hours to install.

Sheet Piles

Sheet piles are composed of interlocking sheets (welded and slid together). Sheets are driven in pairs, as one pile. Fourteen pairs of 20” sheet piles will be driven. Each installation will take approximately 4 hours, and will occur over 163 days during Phase 1.

Fender Piles

To protect the dock from moored vessels, sixty-one 36” diameter steel piles will be installed along the dock face. Each installation will take approximately 4 hours, and 12 fender piles will be driven over 6 days across three years during Phase 1. Twenty-one of the piles will be along the short arm of the “L” causeway and the remainder will be along the long arm.

2.1.2 Mitigation Measures

1. The USACE will inform NMFS of impending in-water activities a minimum of one week prior to the onset of those activities.

2. If construction activities will occur outside of the time window specified in this opinion, the applicant will notify NMFS of the situation at least 60 days prior to the end of the specified time window to allow for reinitiation of consultation.

3. The USACE will require Spill Prevention, Control, and Countermeasure (SPCC) Plans for both land and vessel operations.

4. Project-associated staff will cut all materials that form closed loops (e.g., plastic packing bands, rubber bands, and all other loops) prior to proper disposal in a closed and secured trash bin. Trash bins will be properly secured with locked or secured lids that cannot blow open, preventing trash from entering into the environment, thus reducing the risk of entanglement in the event that waste enters marine waters.

5. Project-associated staff will properly secure all ropes, nets, and other marine mammal entanglement hazards to ensure they do not blow or wash overboard.

Protected Species Observer (PSO)-related measures

6. One or more PSOs will perform PSO duties onsite throughout impact pile driving, vibratory pile driving, dredging, and vessel transit.

7. For each in-water activity, PSOs will monitor all marine waters within the indicated radius for that activity (Table 3).

8. Prior to commencing pile driving and dredging, PSOs will scan waters within the impact pile driving, vibratory pile driving, and dredging shutdown zones and confirm no listed species are within the shutdown zone for at least 30 minutes immediately prior to initiation of the in-water activity. If one or more listed species are observed within the shutdown zone, the in-water activity will not begin until all of the listed species exit the shutdown zone of their own accord, or the shutdown zone has remained clear of all listed species for 30 minutes immediately prior to pile driving and dredging.

9. The on-duty PSOs will continuously monitor the shutdown zone and adjacent waters during pile driving and dredging operations for the presence of listed species.

10. In-water activities will take place only:
    a. between civil dawn and civil dusk;
    b. during conditions with a Beaufort Sea State of 4 or less; and
    c. when the entire shutdown zone and adjacent waters are visible (e.g., monitoring effectiveness is not reduced due to rain, fog, snow, haze or other environmental/atmospheric conditions).

11. If visibility degrades such that a PSO can no longer ensure that the shutdown zone remains devoid of listed species during pile driving and dredging, the crew will cease in-water work until the entire shutdown zone is visible and the PSO has indicated that the zone has remained devoid of listed species for 30 minutes.

12. The PSO will order the pile driving and dredging activities to immediately cease if one or more listed species has entered, or appears likely to enter, the associated shutdown zone.

13. If pile driving and dredging activities are shut down for less than 30 minutes due to the presence of listed-species in the shutdown zone, pile driving and dredging may commence when the PSO provides assurance that listed species were observed exiting the shutdown zone. Otherwise, the activities may only commence after the PSO provides assurance that listed species have not been seen in the shutdown zone for 30 minutes (for cetaceans) or 15 minutes (for pinnipeds).

Table 3. Level A shutdown zone and Level B monitoring radii in meters by activity[1].

Activity	Level A Shutdown Zone Radius	Level B Harassment Zone Radius
Vibratory installation/removal, 24" pipe, temporary template piles	10	2,000
Impact installation, 24" pipe, temporary template piles	150	1,000
Vibratory installation/removal, 14" H-pile, temporary template piles	10	1,000
Impact installation, 14" H-pile, temporary template piles	150	200
Vibratory installation, 14" H-anchor piles	10	1,000
Impact installation, 14" H-anchor piles	150	200
Vibratory installation, 20" sheet piles	20	5,200
Impact installation, 20" sheet piles	150	1,000
Vibratory installation, 36" fender pipe piles	30	21,600
Impact installation, 36" fender pipe piles	210	1,600
Dredging	300	300

14. Following a lapse of pile driving and dredging activities of more than 30 minutes, the PSO will authorize resumption of activities (using soft-start procedures for impact pile driving activities) only after the PSO provides assurance that listed species have not been present in the shutdown zone for at least 30 minutes immediately prior to resumption of operations.

15. If a listed species is observed within a shutdown zone during in-water work, or is otherwise harassed, harmed, injured, or disturbed, PSOs will immediately report that occurrence to NMFS using the contact information specified in Table 4.

[1] Observable radius by a PSO is assumed to be 2,000 meters

Protected Species Observer Requirements

16. PSOs must be independent (i.e., not construction personnel) and have no other assigned tasks during monitoring periods.

17. The action agency or its designated non-Federal representative will provide resumes or qualifications of PSO candidates to the NMFS consultation biologist or ESA Section 7 coordinator for approval at least one week prior to in-water work. NMFS will provide a brief explanation of lack of approval in instances where an individual is not approved.

18. At least one PSO will have prior experience performing the duties of a PSO during construction activity.

Table 4. Summary of Agency Contact Information.

Reason for Contact	**Contact Information**
Request S7 Consultation	AKR.PRD.Section7@noaa.gov
Consultation Questions & Unauthorized Take	Greg Balogh: greg.balogh@noaa.gov & Marilyn Myers: Marilyn.myers@noaa.gov
Reports & Data Submittal	AKR.section7@noaa.gov (include NMFS AKRO tracking number in subject line)
Stranded, Injured, Entangled, or Dead Marine Mammal	NOAA Fisheries Stranding Hotline (24/7 coverage) 877-925-7773
Oil Spill & Hazardous Materials Response	U.S. Coast Guard National Response Center: 1-800-424-8802 & AKRNMFSspillResponse@noaa.gov
Illegal Activities	NMFS Office of Law Enforcement (AK Hotline): 1-800-853-1964
In The Event This Contact Information Becomes Obsolete	NMFS Anchorage Main Office: 907-271-5006 Or NMFS Juneau Main Office: 907-586-7236

19. At least one PSO will complete PSO training prior to deployment. The training will include:
    a. field identification of marine mammals and marine mammal behavior;
    b. ecological information on marine mammals and specifics on the ecology and management concerns of those marine mammals;
    c. ESA and MMPA regulations;

   d. proper equipment use;
   e. methodologies in marine mammal observation and data recording and proper reporting protocols; and
   f. an overview of PSO roles and responsibilities.

21. Where a team of three or more PSOs are required, a lead observer or monitoring coordinator must be designated.

22. PSOs will:
    a. have vision correctable to 20-20;
    b. be able to collect field observations and record field data accurately and in accordance with project protocols;
    c. be able to identify to species all marine mammals that occur in the action area;
    d. have writing skills sufficient to create understandable records of observations.

23. PSOs will work in shifts lasting no longer than 4 hours with at least a 1-hour break from monitoring duties between shifts. PSOs will not perform PSO duties for more than 12 hours in a 24-hour period.

24. PSOs will have the ability to effectively communicate orally, by radio and in person, with project personnel to provide real-time information on listed species.

25. PSOs will have the ability and authority to order appropriate mitigation response, including shutdowns, to avoid takes of all listed species.

26. The PSOs will have the following equipment to address their duties:
    a. tools which enable them to accurately determine the position of a marine mammal in relationship to the shutdown zone;
    b. two-way radio communication, or equivalent, with onsite project manager;
    c. tide tables for the project area;
    d. time-keeping device;
    e. binoculars (7x50 or higher magnification) with built-in rangefinder or reticles (rangefinder may be provided separately);
    f. instruments that allow observer to determine geographic coordinates of observed marine mammals;
    g. a legible copy of this opinion and all appendices; and
    h. legible and fillable observation record form allowing for required PSO data entry.

27. Prior to commencing in-water work or at changes in watch, PSOs will establish a point of contact with the construction crew. The PSO will brief the point of contact as to the shutdown procedures if listed species are observed likely to enter or within the shutdown zone, and will request that the point of contact instruct the crew to notify the PSO when a marine mammal is observed. If the point of contact goes "off shift" and delegates his duties, the PSO must be informed and brief the new point of contact.

Impact Pile driving

27. If no listed species are observed within the impact pile driving shutdown zone for 30 minutes immediately prior to pile driving, soft-start procedures will be implemented immediately prior to activities. Soft start requires contractors to provide an initial set of strikes at no more than half the operational power, followed by a 30 second waiting period, then two subsequent reduced power strike sets. A soft start must be implemented at the start of each day's impact pile driving, any time pile driving has been shutdown or delayed due the presence of a listed species, and following cessation of pile driving for a period of 30 minutes or longer.

28. Following this soft-start procedure, operational impact pile driving may commence and continue provided listed species remain absent from the shutdown zone.

Vibratory Pile Driving

29. If no listed species are observed within the vibratory pile driving shutdown zone for 30 minutes immediately prior to pile driving, vibratory pile driving may commence. This pre-pile driving observation period will take place at the start of each day's vibratory pile driving, each time pile driving has been shut down or delayed due the presence of a listed species, and following cessation of pile driving for a period of 30 minutes or longer.

Dredging

30. All vessels involved in dredging operations, will transit at velocities below 10 kn.

31. Dredging activities must shut down whenever a listed marine mammal approaches within 300 m.

Placement of Fill

32. Fill material will consist of rock fill that is free of fine sediments to the extent practical, to reduce suspended materials from entering the water column.

Vessels

33. Vessel operators will:
    a. maintain a watch for marine mammals at all times while underway;
    b. stay at least 91 meters (m) (100 yards (yds)) away from listed marine mammals, except they will remain at least 460 m (500 yds) from endangered North Pacific right whales;
    c. travel at less than 5 kn (9 km per hour) when within 274 m (300 yds) of a whale;
    d. avoid changes in direction and speed when within 274 m (300 yds) of a whale, unless doing so is necessary for maritime safety;

   e. not position vessel(s) in the path of a whale, and will not cut in front of a whale in a way or at a distance that causes the whale to change direction of travel or behavior (including breathing/surfacing pattern);
   f. check the waters immediately adjacent to the vessel(s) to ensure that no whales will be injured when the propellers are engaged; and
   g. reduce vessel speed to 10 kn or less when weather conditions reduce visibility to 1.6 km (1 mile) or less.

34. Adhere to the Alaska Humpback Whale Approach Regulations when vessels are transiting to and from the project site: (see 50 CFR §§ 216.18, 223.214, and 224.103(b)) (note: these regulations apply to all humpback whales). Specifically, pilot and crew will not:
    a. approach, by any means, including by interception (i.e., placing a vessel in the path of an oncoming humpback whale), within 100 yds of any humpback whale;
    b. cause a vessel or other object to approach within 100 yds of any humpback whale; or
    c. disrupt the normal behavior or prior activity of a whale by any other act or omission.

35. If a whale's course and speed are such that it will likely cross in front of a vessel that is underway, or approach within 91m (100 yds) of the vessel, and if maritime conditions safely allow, the engine will be put in neutral and the whale will be allowed to pass beyond the vessel, except that vessels will remain 460 m (500 yds) from North Pacific right whales.

36. Vessels will take reasonable steps to alert other vessels in the vicinity of whale(s).

37. Vessels will not allow lines to remain in the water unless both ends are under tension and affixed to vessels or gear. No materials capable of becoming entangled around marine mammals will be discarded into marine waters.

Vessel Transit, North Pacific Right Whales, and their critical habitat

38. Vessels will:
    a. remain at least 460 m (500 yds) from North Pacific right whales; and
    b. avoid transiting through designated North Pacific right whale critical habitat if practicable (50 CFR 226.215). If traveling through North Pacific right whale critical habitat cannot be avoided, vessels will:
        i. travel through North Pacific right whale critical habitat at 5 kn or less; or at 10 kn or less while PSOs maintain a constant watch for marine mammals from the bridge; and
        ii. maintain a log indicating the time and geographic coordinates at which vessels enter and exit North Pacific right whale critical habitat.

Vessel Transit, Western DPS Steller sea lions, and their critical habitat.

39. Vessels will not approach within 5.5 km (3 nm) of rookery sites listed in (50 CFR § 224.103(d)).

40. Vessels will not approach within 914 m (3,000 ft) of any other Steller sea lion haulout or rookery.

Vessel Transit, Cook Inlet Beluga Whales, and their critical habitat.

41. Project vessel(s) operating in Cook Inlet will maintain a distance of at least 1.5 miles (mi) south of the mean lower low water (MLLW) line between the Little Susitna River and Beluga River (Figure 6).

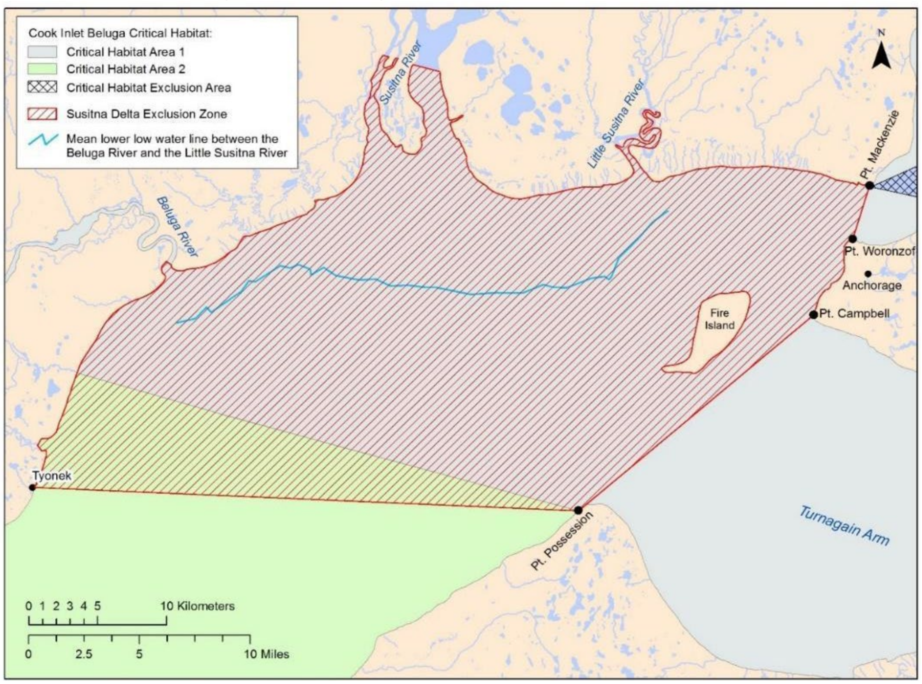

Figure 6. Susitna Delta Exclusion Zone for preventing disturbance to beluga whales.

General Data Collection and Reporting

Data Collection

42. PSOs will record observations on data forms or into electronic data sheets.

43. The action agency will ensure that PSO data will be submitted electronically in a format that can be queried such as a spreadsheet or database (i.e. digital images of data sheets are not sufficient).

44. PSOs will record the following:

a. the date, shift start time, shift stop time, and PSO identifier;
b. PSOs locations during marine mammal monitoring;
c. date and time of each reportable event (e.g., a marine mammal observation, operation shutdown, reason for operation shutdown, change in weather);
d. weather parameters (e.g., percent cloud cover, percent glare, visibility) and sea state where the Beaufort Wind Force Scale will be used to determine sea-state (https://www.weather.gov/mfl/beaufort);
e. species, numbers, and, if possible, sex and age class of observed marine mammals, along with the date, time, and location;
f. the predominant anthropogenic sound-producing activities occurring during each marine mammal observation;
g. bearing and direction of travel of observed marine mammal(s);
h. observations of marine mammal behaviors and reactions to anthropogenic sounds and presence;
i. initial, closest, and last location of marine mammals, including distance from observer to the marine mammal, and minimum distance from the predominant sound-producing activity or activities to marine mammals;
j. whether the presence of marine mammals necessitated the implementation of mitigation measures to avoid acoustic impact, and the duration of time that normal operations were affected by the presence of marine mammals; and
k. geographic coordinates for the observed animals, with the position recorded by using the most precise coordinates practicable (coordinates will be recorded in decimal degrees, or similar standard (and defined) coordinate system).

Data Reporting

45. All observations of North Pacific right whales will be reported to NMFS within 24 hours. These observation reports will include the following information:
    a. date, time, and geographic coordinates of the observation(s);
    b. number of North Pacific right whales observed, including number of adults/juveniles/calves observed, if determinable; and
    c. environmental conditions as they existed during each observation event, including sea conditions, weather conditions, visibility, lighting conditions, and percent ice cover.

46. When project vessels are travelling within North Pacific right whale critical habitat in a manner that requires the use of PSOs (i.e., Vessel is travelling within North Pacific right whale critical habitat at greater than 5 kn), PSOs will collect, organize, and report on vessel travel within North Pacific right whale critical habitat and on marine mammal observations made within that critical habitat. These reports will be submitted to akr.section7@noaa.gov by the end of the calendar year. The report will outline the following information:
    a. ship logs (time and location at which a vessel entered and exited North Pacific right whale critical habitat);

b. species, date, and time for each observation;
c. number of animals per observation event; and number of adults/juveniles/calves per observation event (if determinable);
d. geographic coordinates for the observed animals, with the position recorded by using the most precise coordinates practicable (coordinates will be recorded in decimal degrees, or similar standard (and defined) coordinate system);
e. environmental conditions as they existed during each observation event, including sea conditions, weather conditions, visibility, lighting conditions, and percent ice cover; and
f. photographs and video of North Pacific right whales that were encountered.

47. Observations of humpback whales will be transmitted to akr.section7@noaa.gov by the end of the calendar year, including:
    a. photographs (especially flukes) and video obtained;
    b. geographic coordinates for the observed animals, with the position recorded by using the most precise coordinates practicable (coordinates will be recorded in decimal degrees, or similar standard (and defined) coordinate system);
    c. number of humpback whales observed, including number of adults/juveniles/calves observed (if determinable); and
    d. environmental conditions as they existed during each observation event, including sea conditions, weather conditions, visibility, lighting conditions, and percent ice cover.

Monthly Report

48. Submit interim monthly PSO monitoring reports, including data sheets. These reports will include a summary of ESA-listed marine mammal species and behavioral observations, shutdowns or delays, and work completed.

49. Monthly reports will be submitted to akr.section7@noaa.gov by the 15th day of the month following the reporting period. For example the report for activities conducted in June, 2024 will be submitted by July 15th, 2024.

Final Report

50. A final report will be submitted to NMFS within 90 calendar days of the completion of the project summarizing the data recorded and submitted to akr.section7@noaa.gov. The report will summarize all in-water activities associated with the proposed action, and results of PSO monitoring conducted during the in-water project activities.

51. The final report will include:
    a. summaries of monitoring efforts including dates and times of construction, dates and times of monitoring, and dates and times and duration of shutdowns due to

marine mammal presence;

b. date and time of marine mammal observations by PSO identifier, geographic coordinates of PSO at the time of observation of marine mammals, geographic coordinates at their closest approach to the project site, marine mammal species, numbers, age, size, and gender categories (if determinable), group sizes, and behavioral state;
c. number of marine mammals observed (by species) during periods with and without project activities (and other variables that could affect detectability);
d. observed marine mammal behaviors and movement types versus project activity at time of observation;
e. numbers of marine mammal observations/individuals seen versus project activity at time of observation;
f. distribution of marine mammals around the action area versus project activity at time of observation; and
g. digital, queryable documents containing PSO observations and records, and digital, queryable reports.

Unauthorized Take

52. If a listed marine mammal is determined by the PSO to have been disturbed, harassed, harmed, injured, or killed (e.g., a listed marine mammal(s) is observed entering a shutdown zone before operations can be shut down, or is injured or killed as a direct or indirect result of this action), the PSO will report the incident to NMFS within one business day, with information submitted to akr.section7@noaa.gov. These PSO records will include:
    a. all information to be provided in the final report (see Mitigation Measures under the *Final Report* heading below):
        i. number of animals of each threatened and endangered species affected;
        ii. the date, time, and location of each event (provide geographic coordinates);
        iii. description of the event;
        iv. the time the animal(s) was first observed or entered the shutdown zone, and, if known, the time the animal exited the zone or was last seen in the zone, and the fate of the animal;
        v. mitigation measures implemented prior to and after the animal was taken;
        vi. if a vessel struck a marine mammal, the contact information for the PSO on duty, or the contact information for the individual piloting the vessel if there was no PSO on duty; and
        vii. existing photographs or video footage of the animal(s).

Stranded, Injured, Sick or Dead Marine Mammal (not associated with the project)

53. If PSOs observe an injured, sick, or dead marine mammal (i.e., stranded marine mammal), they will notify the Alaska Marine Mammal Stranding Hotline at 1-877-925-

7773. The PSOs will submit photos and available data to aid NMFS in determining how to respond to the stranded animal. If possible, data submitted to NMFS in response to stranded marine mammals will include date/time, location of stranded marine mammal, species and number of stranded marine mammals, description of the stranded marine mammal's condition, event type (e.g., entanglement, dead, floating), and behavior of live-stranded marine mammals.

Illegal Activities

54. If PSOs observe marine mammals being disturbed, harassed, harmed, injured, or killed (e.g., feeding or unauthorized harassment), these activities will be reported to NMFS Alaska Region Office of Law Enforcement at 1-800-853-1964 (Table 4).

55. Data submitted to NMFS will include date, time, location, description of the event, and any photos or videos taken.

2.2 Action Area

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

The Action Area for this proposed action includes the ensonified marine waters resulting from construction at the Port, and the vessel transit routes. The amount of area that will be ensonified will vary by activity with the largest area extending 21,600 m eastward from the causeway when the 36-inch piles are being installed. Appendix 1 shows the various sized Level B harassment zones for the different activities and Figures 3, 4 and 5 above, show the general area and transit routes that are part of the action area.

3 APPROACH TO THE ASSESSMENT

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

To jeopardize the continued existence of a listed species means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR § 402.02). As NMFS explained when it promulgated this definition, NMFS considers the likely impacts to a species' survival as well as likely impacts to its recovery. Further, it is possible that in certain, exceptional circumstances, injury to recovery alone may result in a jeopardy 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(s) of critical habitat for Western DPS Steller sea lions, Cook Inlet beluga whales, and North Pacific right 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). Thus, essential features of ringed seal, bearded seal, Mexico DPS humpback whale, and Western North Pacific humpback whale critical habitat are described as 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 opinion, our use of the term PBF also applies to Primary Constituent Elements and essential features.

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

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

- Identify the range-wide status of the species and critical habitat likely to be adversely affected by the proposed action. This section describes the current status of each listed species and its critical habitat relative to the conditions needed for recovery. We determine the range-wide status of critical habitat by examining the condition of its PBFs - which were identified when the critical habitat was designated. Species and critical habitat status are discussed in Section 4 of this opinion.

- Describe the environmental baseline including: past and present impacts of Federal, state, or private actions and other human activities *in the action area*; anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation, and the impacts of state or private actions that are contemporaneous with the consultation in process. The environmental baseline is discussed in Section 5 of this opinion.

- Analyze the effects of the proposed action. Identify the listed species that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our *exposure analyses*). In this step of our analyses, we try to identify the number, age (or life stage), and 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 PBFs. The effects of the action are described in Section 6 of this opinion with the exposure analysis described in Section 6.2 of this opinion.

- Once we identify which listed species are likely to be exposed to an action's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how those listed species are likely to respond given their exposure (these represent our *response analyses*). Response analysis is considered in Section 6.3 of this opinion.

- Describe any cumulative effects. Cumulative effects, as defined in NMFS's implementing regulations (50 CFR § 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation. Cumulative effects are considered in Section 7 of this opinion.

- Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat. In this step, NMFS adds the effects of the action (Section 6) to the environmental baseline (Section 5) and the cumulative effects (Section 7) to assess whether the action could reasonably be expected to: (1) appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat (Section 4). Integration and synthesis with risk analyses occurs in Section 8 of this opinion.

- Reach jeopardy and adverse modification conclusions. Conclusions regarding jeopardy and the destruction or adverse modification of critical habitat are presented in Section 9. These conclusions flow from the logic and rationale presented in the Integration and Synthesis Section 8.

- If necessary, define a reasonable and prudent alternative (RPA) 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 RPA to the action.

4 RANGEWIDE STATUS OF THE SPECIES AND CRITICAL HABITAT

This opinion considers the effects of the proposed action on the species and designated critical habitats specified in Table 5.

Table 5. Listing Status and critical habitat designation for species considered in this opinion.

Species	Status	Listing	critical habitat
Bowhead whale (*Balanea mysticetus*)	Endangered	NMFS 1970, 35 FR 18319	Not designated
Ringed Seal, Arctic Subspecies (*Phoca hispida hispida*)	Threatened	NMFS 2012, 77 FR 76706	NMFS 2022, 87 FR 19232
Bearded Seal, Beringia DPS (*Erignathus barbatus nauticus*)	Threatened	NMFS 2012, 77 FR 76740	NMFS 2022, 87 FR 19180
Steller Sea Lion, Western DPS (*Eumetopias jubatus*)	Endangered	NMFS 1997, 62 FR 24345	NMFS 1993, 58 FR 45269
North Pacific Right Whale (*Eubalaena japonica*)	Endangered	NMFS 2008, 73 FR 12024	NMFS 2008, 73 FR 19000
Humpback Whale, Western North Pacific DPS (*Megaptera novaeangliae*)	Endangered	NMFS 2016, 81 FR 62260	NMFS 2021 86 FR 21082
Humpback Whale, Mexico DPS (*Megaptera novaeangliae*)	Threatened	NMFS 2016, 81 FR 62260	NMFS 2021 86 FR 21082
Fin whale (*Balaenoptera physalus*)	Endangered	NMFS 1970, 35 FR 18319	Not designated
Gray whale, Western North Pacific DPS (*Eschrichtius robustus*)	Endangered	NMFS 1970, 35 FR 18319	Not designated
Cook Inlet beluga whale (*Delphinapterus leucas*)	Endangered	NMFS 2008, 73 FR 62919	NMFS 2011, 76 FR 20180

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

As described in the Approach to the Assessment section of this opinion, NMFS uses two criteria to identify those endangered or threatened species or critical habitats 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 activities and a listed species or designated critical habitat.

The second criterion is the probability of a response given exposure. For endangered or threatened species, we consider the susceptibility of the species that may be exposed. For example, species exposed to vessel sound that are not likely to exhibit physical, physiological, or behavioral responses given that exposure (at the combination of sound pressure levels and distances associated with an exposure), are unlikely adversely affected by the exposure. We determine that an action would not likely adversely affect an animal if one could not meaningfully measure or detect the effects, or if the effects are extremely unlikely to occur.

In addition, if proposed activities are not likely to destroy or adversely modify critical habitat, further analysis is not required.

We applied these criteria to the species and critical habitats listed above and determined that the following species and designated critical habitats are not likely to be adversely affected by the proposed action: Western North Pacific DPS humpback whale, Mexico DPS humpback whale, North Pacific right whale, Western North Pacific DPS gray whale, fin whale, Cook Inlet beluga whale, and critical habitat for Mexico DPS humpback whale, Western North Pacific DPS humpback whale, North Pacific right whale, Cook Inlet beluga whale, Steller sea lion, Arctic ringed seal, and Beringia DPS bearded seal. Below we discuss our rationale for those determinations. We applied these same criteria to analyze effects of the proposed project to critical habitat for ringed and bearded seals because project activities will occur within their designated critical habitat. We came to the conclusion that critical habitat for ringed and bearded seals also will not likely be adversely affected by the proposed action. However, because several of the stressors that will occur in bearded and ringed seal critical habitat are different from the stressors that the species we discuss here in section 4.1 have in common, we present our analysis for bearded and ringed seal critical habitat in section 6.1.1., Minor Stressors on ESA listed species and Critical Habitat.

The route proposed for project-specific barges and tugs is from Anchorage to Port of Nome through Cook Inlet and Unimak Pass. These barges and tugs will make approximately 25 trips from Anchorage to Port of Nome and back again. A second project vessel travel route is located within Norton Sound, between Port of Nome and a rock quarry at Cape Nome (Figure 5). Gravel production will take place in the uplands and then the material will be transferred to a barge, which will be transported to Port of Nome with a tug. Up to 250 vessel round trips are expected to along approximately 11.7 nm of coastal marine waters over the life of the project. The transport of quarry materials will occur during 3 construction seasons (May through October), when the waters are free of ice.

The potential adverse effects from project vessel traffic on listed species include:

- auditory and visual disturbance
- vessel strikes
- pollution

4.1.1 Auditory and visual disturbance

The travel route between Anchorage and Nome may create auditory and visual disturbance to Mexico DPS humpback whales, Western North Pacific DPS humpback whales, North Pacific right whales, Western North Pacific gray whales, fin whales, and Cook Inlet beluga whales. The primary underwater sound associated with the proposed vessel operation is the continuous noise produced from propellers; sound is generated by the collapse of air bubbles (cavitation) created when propeller blades move rapidly through the water (Gray and Greeley 1980).

A whale's reaction to vessel disturbance may include approach or deflection from the sound source, low level avoidance, short-term vigilant behavior, short-term masking of echolocation or other acoustic communication among individuals. Behavioral reactions to vessels can vary depending on the type and speed of the vessel, and the spatial relationship between the animal and the vessel. Response also varies between individuals of the same species exposed to the same sound, depending on age and individual animals' past experiences.

Proposed mitigation measures to avoid harassing these whales during vessel transits include: 1) maintaining a watch for marine mammals at all times while underway, 2) reducing vessel speed to less than 5 (kn) when within 274 m (300 yds) of a whale, and 3) avoiding North Pacific right whale critical habitat, where concentrations of this endangered whale are greatest. Even with these avoidance measures, these six whale species may still be exposed to vessel sound; but the sound will be low-frequency, and the duration of the exposure will be temporary (a few minutes) because the vessel will be in transit. Because the sound of the vessels will be continuous, marine mammals will be alerted to their presence before the received level of sound exceeds 120 decibels (dB). Therefore, a startle response is not expected. Rather, deflection and avoidance are expected to be the common responses in those instances where there is any response at all. Moreover, given the overall frequency of vessel traffic along the Anchorage-Nome route (Figure 7 and Figure 8), humpback whales, gray whales, North Pacific right whales, fin whales, and Cook Inlet beluga whales may routinely encounter vessels and may be habituated to vessel noise. NMFS has no expectation of significant disruption of important behaviors, such as feeding, breeding, resting, and migrating, of these whales due to visual or auditory disturbance from vessels travelling between Anchorage and Nome. Any effects from vessel sound could not be meaningfully measured or detected. Thus, we consider such effects to be insignificant.

4.1.2 Vessel Strike

Vessel strike is an ongoing source of mortality for large cetaceans (Vanderlaan and Taggart 2007, Schoeman et al. 2020). Between 1978 and 2012, there were at least 108 recorded whale-vessel collisions in Alaska (Neilson et al. 2012). Twenty-six large whales in Alaska, including 18 humpbacks were struck by vessels between 2016 and 2020 (Freed et al. 2022). Between 2000 and 2022, two live fin whales were confirmed as being struck by a vessel and seven carcasses showed evidence of vessel strike (Mandy Keough pers. comm 2023). Vessel strikes are much more common in Southeast Alaska, but it is not known if this is because of the greater number of whales, the greater amount of vessel traffic, or the greater probability of strikes being reported owing to more people and vessels present at sea (Muto et al. 2021). The probability of strike events depends on the frequency, speed, and route of the marine vessels, as well as distribution of whales in the area. Laist et al. (2001) found that while all sizes and types of vessel can strike a whale, ships greater than 80 m and those going faster than 14 kn were most likely to cause severe or fatal injuries. As an example, two of the three fin whale deaths were caused by large, fast moving vessels (passenger ferry and cruise ship). The ship responsible for the third fatality is unknown (Freed et al. 2022).

Among larger whales, humpback whales, fin whales, and gray whales are the most frequent victims of ship strikes (Laist et al. 2001). There have been three documented large cetacean vessel collisions in Cook Inlet since 2001; one humpback whale, one fin whale, and one unidentified large cetacean (NMFS Alaska Regional Office Stranding Database accessed May 2022). Ship strikes of smaller cetaceans, like Cook Inlet beluga whales, are less common than large whales, possibly due to their smaller size and more agile nature. However, Cook Inlet beluga whales have been photographed with propeller scars (McGuire et al. 2014).

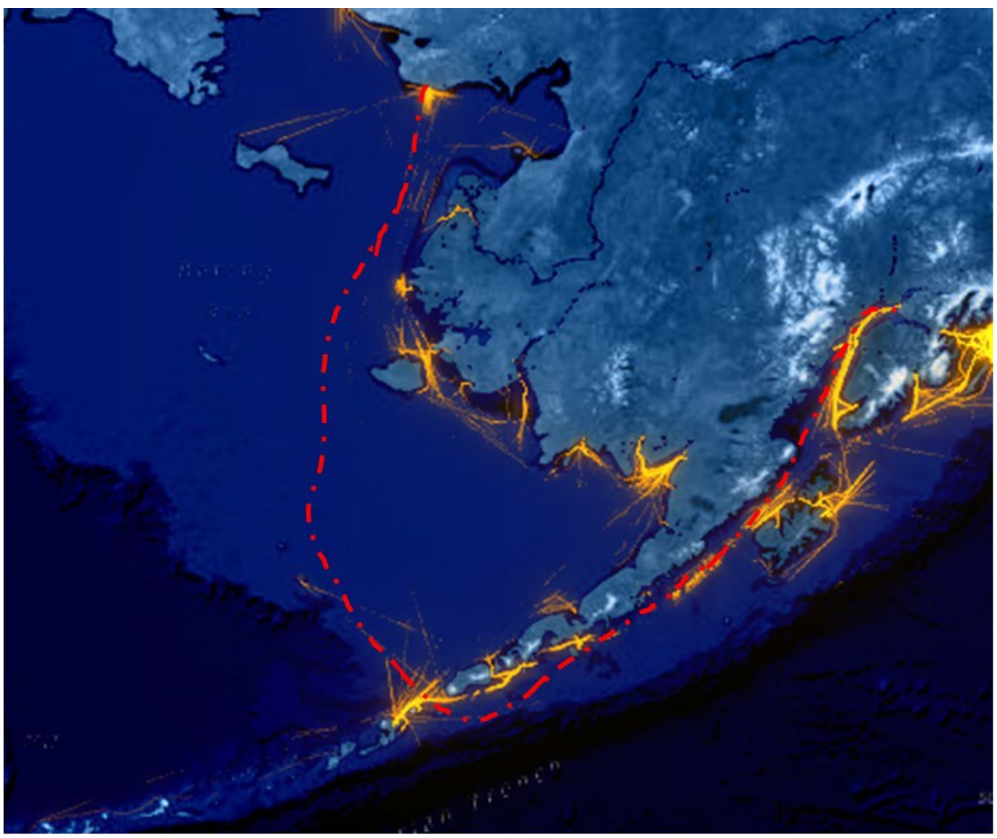

Figure 7. Red line indicates the path of tow vessels along the proposed Anchorage to Nome travel route against a backdrop of yellow vessel tracks from AIS.

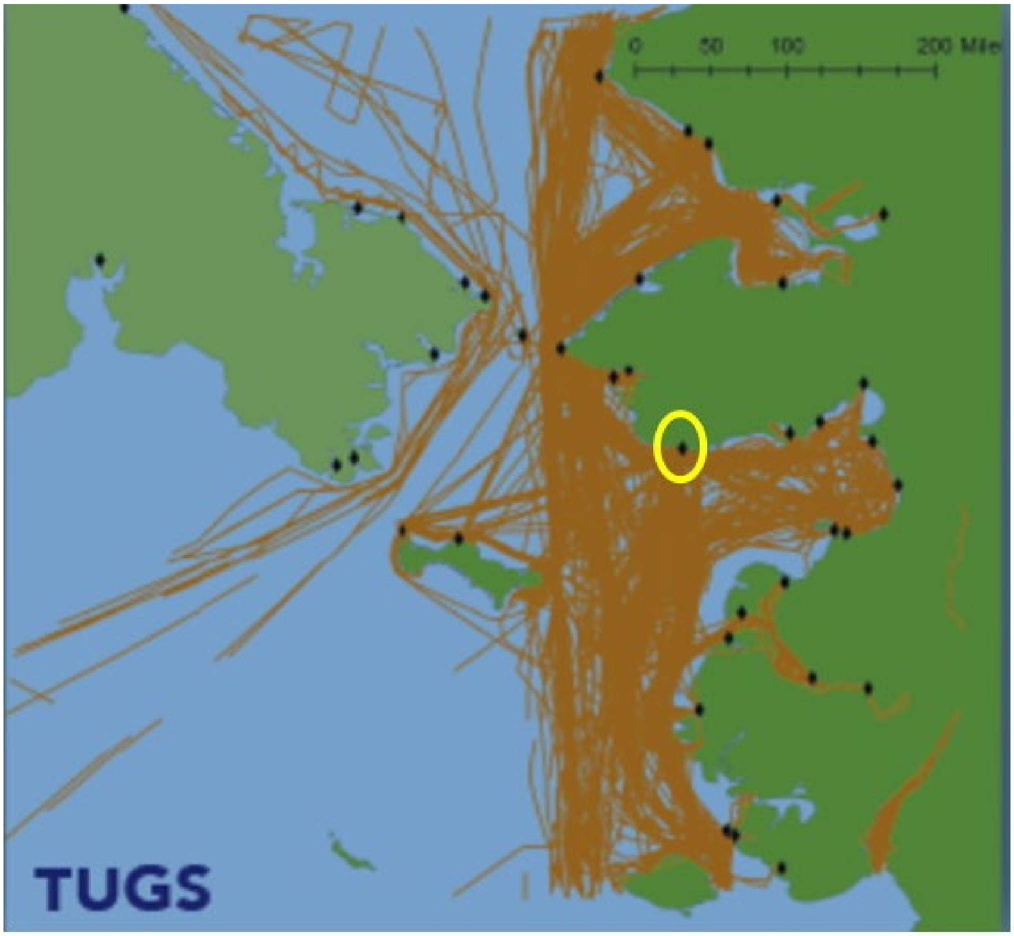

Figure 8. Tug paths in the Bering Sea Region from AIS. Yellow Circle indicates location of the Port of Nome.

Approximately 1.8 Eastern North Pacific gray whales are struck by vessels annually (Carretta et al. 2020); because of their rarity, the number of Western North Pacific gray whales struck annually is likely even less. The Western North Pacific DPS gray whales estimated population size from photo-ID data for Sakhalin and Kamchatka in 2016 was estimated at 290 whales (90 percentile intervals = 271-311; Cooke et al. 2017, Cooke 2018). The specific migration route and timing of the Western North Pacific grays are unknown making it very difficult to predict when and where they pass through the Aleutian chain or along the coast of Alaska. However, given the large population size of the unlisted Eastern North Pacific gray whale (approximately 26,960 animals; Muto et al. 2022) and the relatively small number of the ESA listed Western North Pacific gray whales (approximately 139 animals, 48% of the population; Cooke 2020) that make a trans-Pacific migration, there is a very low likelihood that a Western North Pacific DPS of gray whale will overlap with project-specific barges on the Anchorage to Nome route, and essentially no chance they will overlap with the barge transiting between the Port of Nome and the rock quarry.

The minimum mean annual mortality and serious injury rate due to ship strikes reported in Alaska for humpback whales between 2014 and 2018 was 2.6 whales (Muto et al. 2021). In the Aleutian Island/Bering/Chukchi sea region approximately 2 percent of the whales are in the listed Western North Pacific DPS, 7 percent are in the listed Mexico DPS and 91 percent are in the delisted Hawaii DPS (Wade 2021). Humpback whales struck by a ship represent a very small fraction of the total humpback whale population, and ship strike currently does not pose a risk to population growth or recovery (Laist et al. 2001, Gende et al. 2018).

North Pacific right whales are most likely seen in the Bering Sea, especially near their designated critical habitat, but their exceedingly small population (approximately 30 animals) makes it highly unlikely that they will be encountered. Researchers systematically trying to find North Pacific right whales are rarely successful.

Mitigation measures that apply to cetaceans stipulate that vessels: 1) stay at least 91 m away from listed whales and at least 460 m from endangered North Pacific right whales; 2) travel at less than 5 kn (9 km per hour) when within 274 m of a whale; 3) will avoid approaching marine mammals head-on; 4) operated by or for this proposed project will have personnel assigned to stand watch at all times, day and night when in transit, and 5) will use extreme caution and proceed at a safe speed. We expect that these mitigation measures will greatly reduce the probability of a ship striking a whale.

Given: 1) the low number of vessel strikes that have occurred previously on the transit route between Anchorage and Nome; 2) the relatively low number of transits between Anchorage and Nome; 3) the use of a regularly used transit route where ship traffic is not novel to whales in the area; 4) the implementation of the mitigation measures; and 5) the low likelihood of occurrence of ESA listed whales over the majority of the route, we conclude the probability of project tugs pulling material barges striking whales is discountable.

4.1.3 Pollutants

Pollutant spills or discharges from transiting project vessels could adversely affect Western North Pacific DPS humpback whale, Mexico DPS humpback whale, North Pacific right whale, fin whale, North Pacific gray whale, and Cook Inlet beluga whale. Pollutants can affect marine mammals if contact with skin, inhalation, or ingestion occurs. The impacts of pollutants depend on duration and severity of exposure. In addition to liquid or gas pollutants, solid waste pollution such as marine debris (ship lines, packing bands, etc.) may enter the marine environment and interact with listed species through entanglement and ingestion.

Mitigation measures proposed by the USACE will be in place to minimize the potential for releases of petroleum products and other pollutants into the marine environment, including, but not limited to a SPCC Plan for project-related vessels. We expect that with the implementation of the SPCC plan only small petroleum or other pollutant spills from the deck of a vessel might reach the water. To address some sources of debris, there is also a mitigation measure specific to cutting of all unused packing straps, plastic rings, and other synthetic loops, and securing all ropes and nets, to ensure they do not blow or wash into the marine environment. These measures will help to prevent entanglement of marine wildlife.

Even in the unlikely event of a spill, spills from transiting vessels are unlikely to affect listed species because dispersal and evaporation of fuels and other pollutants are expected to occur quickly due to wind and tidal currents. The listed species found throughout the transit routes are also likely to be widely distributed and not in close proximity to the spill source (transiting vessels). It is unknown what impact marine debris such as packing bands and loops may have on cetacean species. Discarded or lost lines from vessels could become an entanglement hazard for listed cetaceans. However, due to the large area of the project vessel transit routes, the extremely small number of lines expected to be lost from vessels associated with this action, and the relatively low density of cetaceans, we conclude it is unlikely that listed cetacean species will be affected by marine debris.

Considering the wide distribution and low density of the listed cetaceans throughout the transit portions of the action area, and the measures in place to 1) prevent and address pollutant spills from vessels; 2) reduce the entanglement risk of packing bands and loops; and 3) avoid marine mammals while in transit, we conclude that harmful exposure from project-related stressors to Western North Pacific DPS humpback whales, Mexico DPS humpback whales, North Pacific right whales, fin whales, North Pacific gray whales, and Cook Inlet beluga whales, is discountable.

4.1.4 Vessel Effects to Critical Habitat

The potential adverse effects from project vessel traffic on critical habitat include surface disturbance to prey and pollution.

The vessel transit route between Anchorage and Nome will traverse critical habitat designated for Mexico DPS humpback whales, Western North Pacific humpback whales, Cook Inlet beluga whales, and Western DPS Steller sea lion. Additionally, although not expected due projected vessel pathways and to mitigation measures, there is the possibility that some vessels will transit through critical habitat designated for North Pacific right whale. The potential stressors from vessels include disturbance to the waters' surface and pollutants resulting from accidental spills or releases of petroleum products. While the size and composition of a spill influences the severity of effects to critical habitat, the evaporation of fuels and other pollutants are expected to occur quickly due to wind and tidal currents.

A PBF essential for humpback whale, North Pacific right whale, and Cook Inlet beluga critical habitats is an abundance of preferred prey. There is nothing about the passage of ships on the surface of the water that would have a measureable effect on aggregations of their preferred prey species. Eddies or wakes created by vessels across the surface of the water may cause temporary displacement of a relatively small number of zooplankton by creating turbulence, but we do not expect that this disturbance would affect the prey distribution or abundance in a meaningful or measurable way. Likewise, vessel transit is not expected to affect the migration or aggregation of salmon or eulachon that Cook Inlet beluga whales depend upon. An additional PBF for Cook Inlet beluga whale is waters free of toxins or other agents of a type and amount that could be harmful. We expect that all vessels contracted by the USACE will comply with the vessel's SPCC Plan as specified in Mitigation Measure #3. Therefore impacts to PBFs for humpback whale, North Pacific right whale, Steller sea lion,and Cook Inlet beluga whale critical habitat resulting from project vessels transiting are highly unlikely to occur.

We expect the project vessels travelling from Anchorage to Nome will be traveling in well-traveled shipping lanes through Steller sea lion critical habitat. The vessel may pass through special aquatic foraging areas for Steller sea lions. However, passage of the ship on the surface of the water is not expected to disrupt or disturb any of the primary prey species which Steller sea lions depend upon and therefore the quality of their prey resources will not be diminished. For these reasons we conclude that there is no aspect of the passage of the Anchorage-Nome vessel through or near critical habitat that will negatively impact the essential features of Steller sea lion critical habitat.

In summary, considering the mitigation measures in place to prevent and address small spills from vessels, and the unlikely possibility that surface travel will measurably impact prey species, we find that the vessel transits between Anchorage and Nome or Port of Nome and Cape Nome across critical habitat for Western North Pacific DPS humpback whales, Mexico DPS humpback whales, North Pacific right whales, Cook Inlet beluga whales, and Steller sea lions will have an immeasurably small effect on the features determined to be essential for these species. Therefore, we determine that disturbance to critical habitat as a result of vessel traffic is insignificant and pollution is discountable.

4.2 Climate Change

Global climate change is a threat that affects all species. Because it is a shared threat, we present this narrative 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

The listed marine mammals we consider in this opinion live in the ocean and depend on the ocean for nearly every aspect of their life history. Factors which affect the ocean, like temperature and pH, can have direct and indirect impacts on marine mammals and the resources they depend upon. Global climate change may affect all the species we consider in this opinion, but it is expected to affect them differently. First, we provide background on the physical effects climate change has caused on a broad scale; then we focus on changes that have occurred in Alaska. Finally, we provide an overview of how these physical changes translate to biological effects.

4.2.1 Physical Effects of Climate Change

4.2.1.1 Air temperature

There is consensus throughout the scientific community that atmospheric temperatures are increasing, and will continue to increase, for at least the next several decades (Watson and Albritton 2001, Oreskes 2004). The Intergovernmental Panel on Climate Change (IPCC) estimated that since the mid-1800s, average global land and sea surface temperature has increased by 0.85°C (±0.2°C), with most of the change occurring since 1976 (IPCC 2019). This temperature increase is greater than what would be expected given the range of natural climatic variability recorded over the past 1,000 years (Crowley 2000).

Continued emission of greenhouse gases is expected to cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems (IPCC 2019). The average global land and ocean surface temperature for January 2023 was 0.87°C (1.57° Fahrenheit; F) above the 20th century average of 12.0°C (53.6°F). This was the seventh-warmest January in the 174-year global record (https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202301/supplemental/, accessed March 2023).

The impacts of climate change are especially pronounced at high latitudes. 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, albedo, black carbon, and many other factors[2] (Serreze and Barry 2011, Overland et al. 2017). Across Alaska, average air temperatures have been increasing, and the average annual temperature is now 1.65-2.2°C (3-4°F) warmer than during the early and mid-century (Thoman and Walsh 2019). Winter temperatures have increased by 3.3°C (6˚F) (Chapin et al. 2014) and the snow season is shortening (Thoman and Walsh 2019). 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[3]. Some of the most pronounced effects of climate change in Alaska include disappearing sea ice, shrinking glaciers, thawing permafrost, and changing ocean temperatures and chemistry (Chapin et al. 2014).

4.2.1.2 Ocean Heat

Higher air temperatures have led to higher ocean temperatures. More than 90 percent of the excess heat created by global climate change is stored in the world's oceans, causing increases in ocean temperature (IPCC 2019, Cheng et al. 2020). The upper ocean heat content, which

---

[2] 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 2020.

[3] https://www.ncdc.noaa.gov/sotc/national/202013 viewed on 5/31/2021

measures the amount of heat stored in the upper 2,000 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 9) (Thoman and Walsh 2019).

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) declined at a considerably accelerated rate and continues to decline (Stroeve et al. 2007, Stroeve and Notz 2018) (Figure 10). Approximately three-quarters of summer Arctic sea ice volume has been lost since the 1980s (IPCC 2013). In addition, old ice (> 4 years old), which is thicker and more resilient to melting than young ice, constituted 33 percent of the ice pack in 1985, but by March 2019, it represented only 1.2 percent of the ice pack in the Arctic Ocean (Perovich et al. 2019, Meier et al. 2021). Based on data available since 1985, multiyear ice in 2021 reached its second lowest level by the end of summer and ice volume was at a record low (at least since 2010) in April 2021(Meier et al. 2021) (Figure 10). Overland (2020) suggests that the loss of the thicker older ice makes the Arctic ecosystem less resilient. Both the maximum sea ice extent (March) and the minimum (September) have consistently been decreasing, although the summer minimums are more pronounced (Perovich et al. 2019) Figure 10).

Wang and Overland (2009) estimated that the Arctic will become essentially ice-free (i.e., sea ice extent will be less than 1 million km^2) during the summer between the years 2021 and 2043 and modeling with the new generation climate models provides independent support of an ice-free Arctic in mid-century or earlier (Notz and Stroeve 2016, Guarino et al. 2020, SIMIP Community 2020). Once the entire Arctic Ocean becomes a seasonal ice zone, its ecosystem will change fundamentally as sea ice is the key forcing factor in polar oceans (Wassmann et al. 2011).

Related to the loss of sea ice is the northward shift and near loss of the cold-water pool in the eastern Bering Sea. Winter sea ice creates a pool of cold (<2ºC) bottom water that is protected from summer mixing by a thermocline (Mueter and Litzow 2008). With the reduction in winter sea ice, the cold-water pool has shrunk (Figure 11). Many temperate species, especially groundfish, are intolerant of the low temperatures so the extent of sea ice determines the boundary between arctic and subarctic seafloor communities and demersal vs pelagic fish communities (Grebmeier et al. 2006). In the Pacific Arctic, large scale, northward movements of commercial stocks are underway as previously cold-dominated ecosystems warm, and fish move northward to higher latitude, relatively cooler environments (Grebmeier et al. 2006, Eisner et al. 2020). Not only fish, but plankton, crabs and ultimately, sessile invertebrates like clams are affected by these changes in water temperature (Grebmeier et al. 2006, Fedewa et al. 2020).

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).

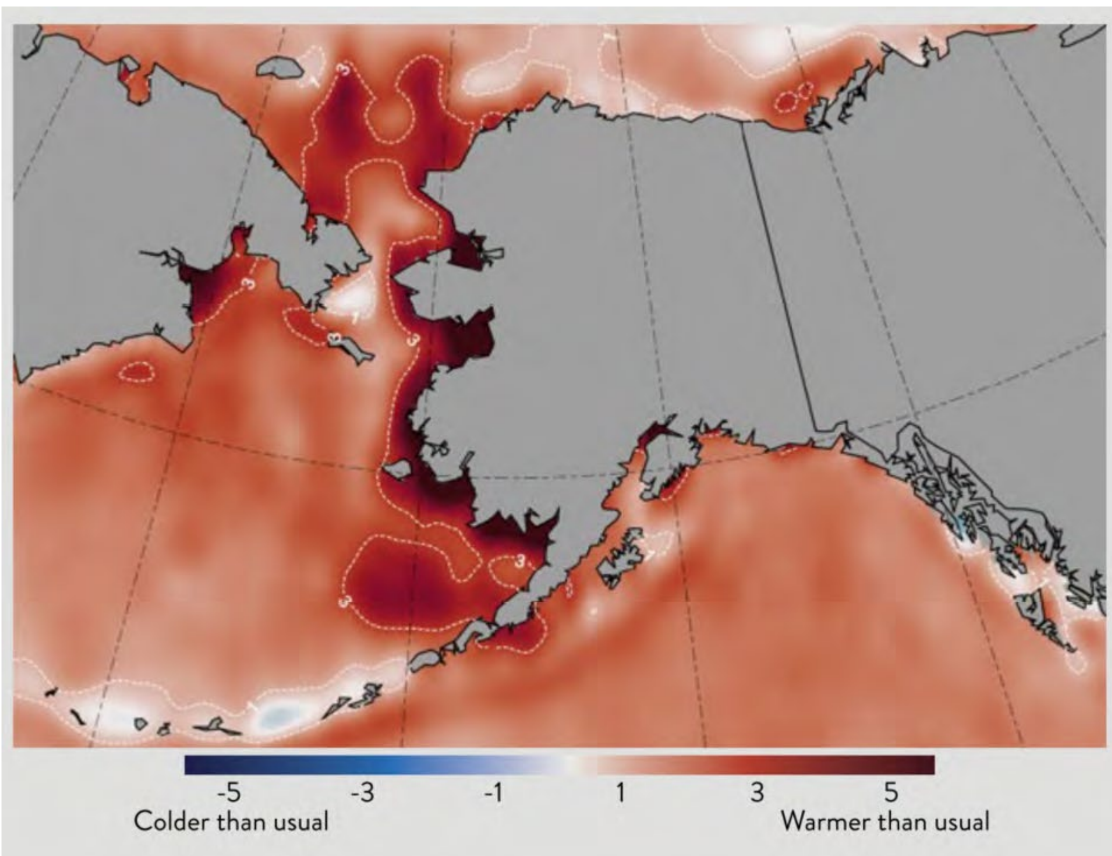

Figure 9. Arctic summer sea surface temperatures, 2019.

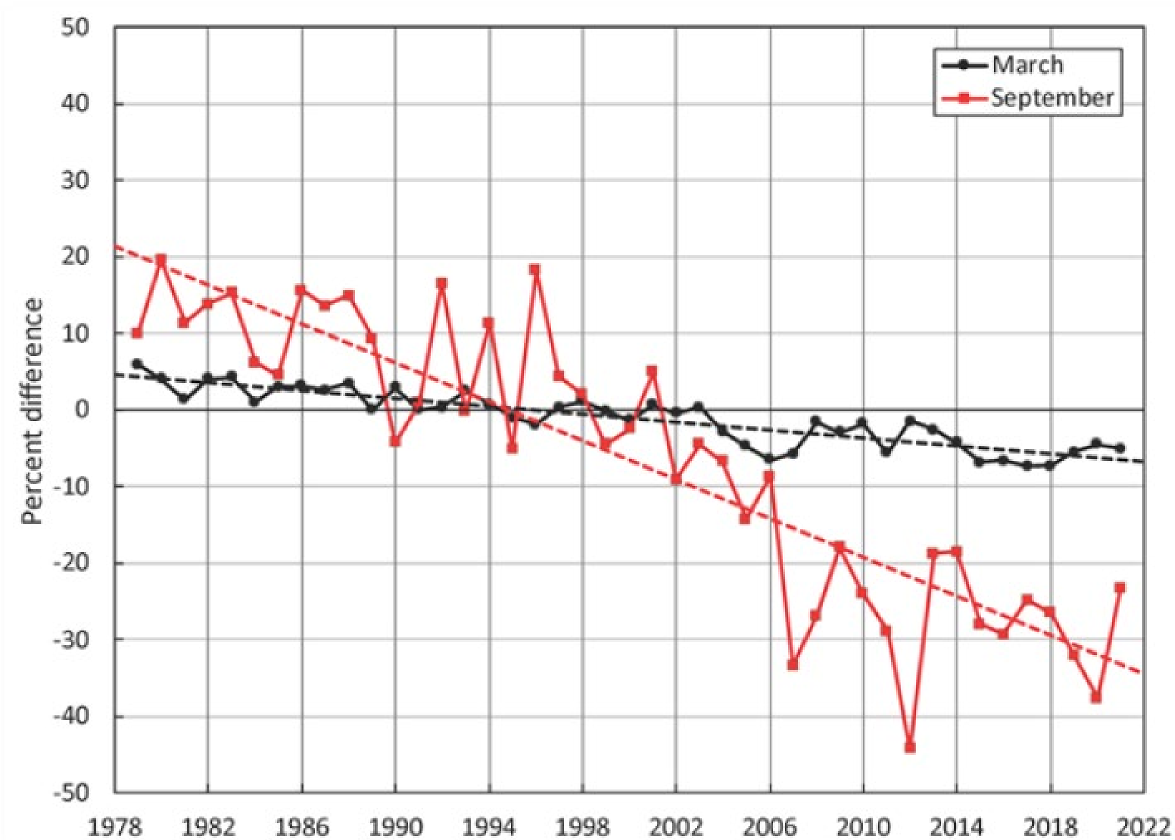

Figure 10. Arctic ice extent declines in September (red) and in March (black). The value for each year is the difference in percent in ice extent relative to the mean values for 1981-2010. Both trends are significant at the 99% confidence level. The slopes of the lines indicate losses of -2.7 for the maximum ice extent and -13.0 percent for the minimum ice extent, per decade (Meier et al. 2021).

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 (Barbeaux et al. 2020). 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.

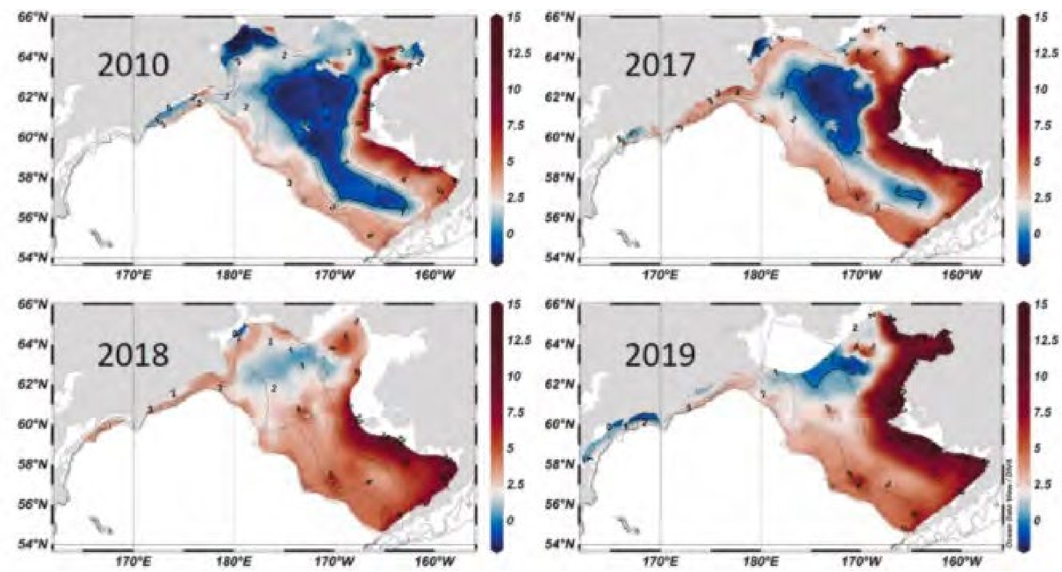

Figure 11. Bottom temperatures from summer oceanographic surveys; a graphic display of cold pool shrinkage over time.

4.2.1.3 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. 2004, Feely et al. 2009). Despite the oceans' role as large carbon sinks, the CO_2 level continues to rise and is currently over 410 ppm[4].

As the oceans absorb CO_2, 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).

High latitude (colder) 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

---

[4] NOAA Global Monitoring Laboratory website. Trends in Atmospheric Carbon Dioxide. Available at https://www.esrl.noaa.gov/gmd/ccgg/trends/, accessed November 2020.

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 (Yamamoto et al. 2012, DeGrandpre et al. 2020).

Undersaturated waters are potentially highly corrosive to any calcifying organism, such as corals, bivalves, crustaceans, echinoderms and many forms of zooplankton such as copepods and pteropods, and consequently may affect Arctic food webs (Fabry et al. 2008, Bates et al. 2009). Pteropods, which are often considered indicator species for ecosystem health, are prey for many species of carnivorous zooplankton, fishes including salmon, mackerel, herring, and cod, and baleen whales (Orr et al. 2005). 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, may be able to adapt to changing ocean conditions (Fabry et al. 2008, Lischka and Riebesell 2012).

4.2.2 Biological Effects of Climate Change

Climate change is projected to have substantial direct and indirect effects on individuals, populations, species, and the structure and function of marine, coastal, and terrestrial ecosystems in the foreseeable future (Hinzman et al. 2005, Burek et al. 2008, Doney et al. 2012, Huntington et al. 2020). The physical effects on the environment described above have impacted, are impacting, and will continue to impact marine species in a variety of ways (IPCC 2014), such as:

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

Some of the biological consequences of the changing Arctic conditions are shown in Table 6 (adapted from Burek et al. 2008).

Climate change is likely to have its most pronounced effects on species whose populations are already in tenuous positions (Isaac 2009). For species that rely primarily on sea ice for major parts of their life history, we expect that the loss of sea-ice would negatively impact those species' ability to thrive.

Table 6. Summary of possible direct and indirect health effects from climate change for Arctic marine mammals.

Direct Effect	Result
Increase in ocean temperature	Changes in distribution and range (fish, whales) Increase in HABs (all affected) Loss of suitable habitat Change in prey base
Loss of sea ice platform (seals)	Reduction of suitable habitat for feeding, resting, molting, breeding Movement, distribution, life history may be affected
Changes in weather	Reduction in snow on sea ice, loss of suitable lair habitat for ringed seals
Ocean acidification	Changes in prey base (all affected)
Indirect Effect	**Result**
Changes in infectious disease transmission rate	Increased host density due to reduced habitat, increasing density-dependent diseases. Epidemic disease due to host or vector range expansion. Increased survival of pathogens in the environment. Interactions between diseases, loss of body condition, and increased immunosuppressive contaminants, resulting in increased susceptibility to endemic or epidemic disease.
Alterations in the predator–prey relationship	Affect body condition and, potentially, immune function.
Changes in toxicant pathways (HABs, variation in long-range transport, biotransport, runoff, increased use of the Arctic)	Mortality events from biotoxins. Toxic effects of contaminants on immune function, reproduction, skin, endocrine systems, etc.
Other negative anthropogenic impacts related to longer open water period	Increased likelihood of ship strikes, fisheries interactions, acoustic injury. Chemical and pathogen pollution due to shipping or aquaculture practices. Introduction of nonnative species.

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

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

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

4.3.1.1 Population Structure and Status

There are two recognized subspecies of the bearded seal: *E. b. barbatus*, often described as inhabiting the Atlantic sector (Laptev, Kara, and Barents seas, North Atlantic Ocean, and Hudson Bay; (Rice 1998)); and *E. b. nauticus*, which inhabits the Pacific sector (remaining portions of the Arctic Ocean and the Bering and Okhotsk seas; (Ognev 1935, Scheffer 1958, Manning 1974, Heptner et al. 1976)). Based on evidence for discreteness and ecological uniqueness, NMFS concluded that the *E. b. nauticus* subspecies consists of two DPSs—the Okhotsk DPS in the Sea of Okhotsk, and the Beringia DPS, encompassing the remainder of the range of this subspecies (75 FR 77496; December 10, 2010). Only the Beringia DPS is found in U.S. waters, including the action area. NMFS has not prepared a Recovery Plan for the Beringia DPS bearded seal.

A recent and reliable population estimate is not available, however, Conn et al. (2014) calculated a preliminary abundance estimate (using a limited sub-sample of spring aerial survey data collected from the eastern Bering Sea in 2012) of 301,836 bearded seals (95% confidence interval (CI): 238,195-371,147). Furthermore, Conn et al. (2014) estimated the mean density of bearded seals over a study area of 767,114 km^2 was 0.39/ km^2 (95% CI: 0.32-0.47).

4.3.1.2 Distribution

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

Bearded seals are closely associated with sea ice, particularly during the critical life history periods related to reproduction and molting, and can be found in a broad range of ice types. They generally prefer moving ice that produces natural openings and areas of open-water (Heptner et al. 1976, Fedoseev 1984, Nelson et al. 1984). They usually avoid areas of continuous, thick, shorefast ice and are rarely seen in the vicinity of unbroken, heavy, drifting ice or large areas of multi-year ice (Fedoseev 1965, Burns and Harbo 1972, Burns and Frost 1979, Burns 1981, Smith 1981, Fedoseev 1984, Nelson et al. 1984).

It is thought that in the fall and winter most bearded seals move south with the advancing ice edge through Bering Strait into the Bering Sea where they spend the winter. In the spring and early summer, as the sea ice melts, many of these seals move north through the Bering Strait into the Chukchi and Beaufort Seas (Burns 1967, Burns and Frost 1979, Burns 1981, Cameron and Boveng 2007, 2009, Cameron et al. 2018). The overall summer distribution is quite broad, with seals rarely hauled out on land (Burns 1967, Heptner et al. 1976, Burns 1981, Nelson et al. 1984).

Quakenbush et al. (2019) found that young bearded seals tagged in the Bering and Chukchi seas made strong seasonal (north in summer and south in fall) movements, but those tagged in the Beaufort Sea did not travel south of ~70 °N. Cameron et al. (2018) found that young bearded seals were closely associated with the ice edge farther south in the Bering Sea. Juvenile bearded seals that were tagged from 2014-2018 primarily occupied shallow coastal waters and areas with intermediate-concentration pack ice or were near the ice edge. Hauling out occurred less in the winter and increased during spring and summer, coinciding with the annual molting period. Some seals, mostly juveniles, have been observed hauled out on land along lagoons and river mouths and far inland in rivers and creeks on the mainland (Huntington 2000).

4.3.1.3 Occurrence in the Action Area

Bearded seals are primarily benthic feeders and are typically found in relatively shallow water (< 200 m), presumably because their prey is more accessible to them in the shallower water. Many bearded seals spend the winter months in the Bering Sea and then move north through the Bering Strait between late April and June. Juveniles may not migrate north to follow the ice, as most adults do, and may remain along the coasts of the Bering and Chukchi Seas. Apart from these juveniles, seasonal distribution appears to be correlated with the ice pack (Muto et al. 2019).

Although bearded seals are abundant throughout the region during spring migration, they become most concentrated in areas with good feeding, early open water, or lingering moving ice. Early open water is observed east of Cape Nome (Oceana and Kawerak 2014). Norton Sound hunters have observed juvenile bearded seals feeding inland on the El Dorado River and in Safety Sound, just east of the action area. In the fall, juvenile bearded seals are at river mouths where fish are concentrated (Figure 12). Larger adult bearded seals are rarely seen close to shore (Simpkins et al. 2003, Bengtson et al. 2005, Oceana and Kawerak 2014).

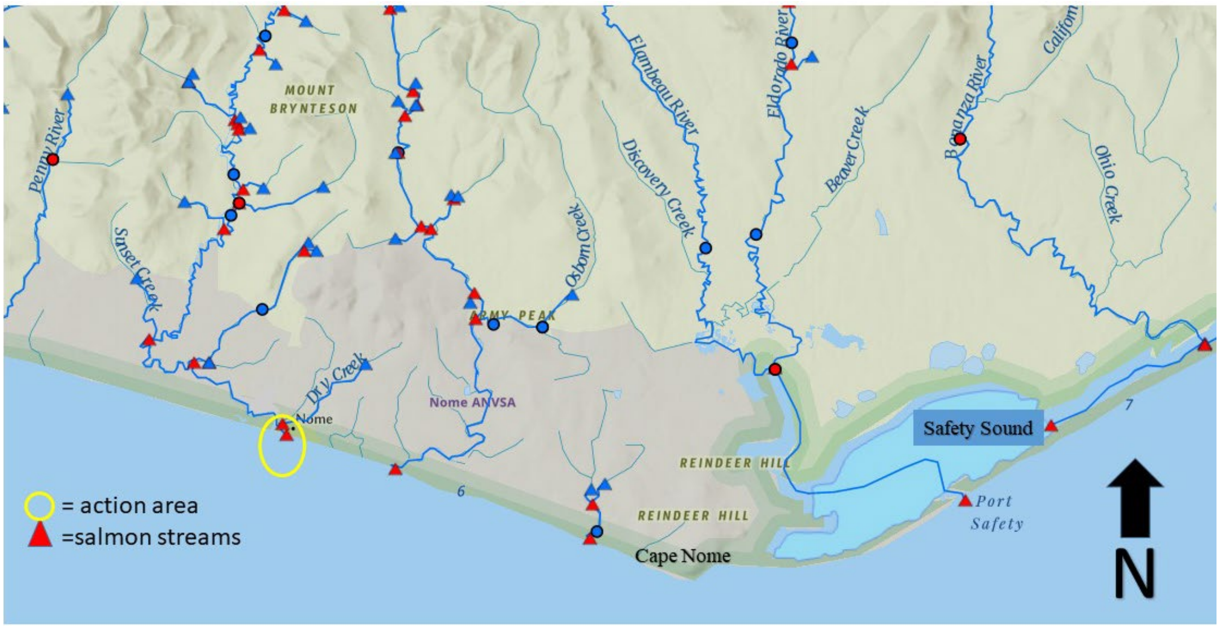

Figure 12. Anadromous fish streams in or near the action area.

4.3.1.4 Feeding, Diving, Hauling Out and Social Behavior

Bearded seals of the Beringia DPS primarily feed on bivalves and crustaceans, along with fishes such as sculpins, cods, and flatfishes (Dehn et al. 2007, Quakenbush et al. 2011a, Crawford et al. 2015). Bearded seals "scan" the surface of the seafloor with their highly sensitive whiskers, burrowing only in the pursuit of prey (Marshall et al. 2006, Marshall et al. 2008).

The diving behavior of adult bearded seals is closely related to their benthic foraging habits and in the few studies conducted so far, dive depths have largely reflected local bathymetry (Gjertz et al. 2000, Krafft et al. 2000). Studies using depth recording devices have until recently focused on lactating mothers and their pups. These studies showed that mothers in the Svalbard Archipelago make relatively shallow dives, generally <100 m in depth, and for short periods, generally less than 10 minutes in duration. Adult females spent most of their dive time (47-92 percent) performing U-shaped dives, believed to represent bottom feeding (Krafft et al. 2000); U-shaped dives are also common in nursing pups (Lydersen et al. 1994).

Individual male bearded seals use distinct vocalizations during the breeding season which are believed to advertise mate quality, signal competing claims on reproductive rights, or to identify territory. Studies in the fjords of the Svalbard Archipelago and shore leads in the Chukchi Sea of Alaska have suggested site fidelity of males within and between years supporting earlier claims that males defend aquatic territories (Cleator et al. 1989, Cleator and Stirling 1990, Van Parijs et al. 2003, Van Parijs et al. 2004, Van Parijs and Clark 2006, Risch et al. 2007). Males exhibiting territoriality maintain a ≤ 12 km^2 core area, unlike wandering males that call across several larger core areas (Van Parijs et al. 2003, Van Parijs et al. 2004, Van Parijs and Clark 2006, Risch et al. 2007). Scars on the males suggest fighting may be involved in defending territories as well.

4.3.1.5 Vocalization, Hearing, and Other Sensory Capabilities

Bearded seals vocalize underwater in association with territorial and mating behaviors. The predominant calls produced by males during breeding, termed trills, are described as frequency modulated vocalizations. Trills show marked individual and geographical variation, are uniquely identifiable over long periods, can propagate up to 30 km (19 mi), are up to 60 seconds in duration, and are usually associated with stereotyped dive displays (Cleator et al. 1989, Van Parijs et al. 2001, Van Parijs 2003, Van Parijs et al. 2003, Van Parijs et al. 2004, Van Parijs and Clark 2006). NMFS defines the functional hearing range for phocids (including bearded seals) as 50 Hz to 86 kHz (NMFS 2018b).

Hearing thresholds for two captive bearded seals were measured for underwater tonal sounds at frequencies between 0.1 and 61 kHz, under quiet controlled conditions and in the presence of octave-band masking sound (Sills et al. 2020). The bearded seals displayed sensitive underwater hearing with peak sensitivity near 50 dB (decibel) re 1 µPa (micro pascal) and a broad frequency range of best hearing extending from approximately 0.3 to 45 kHz, while the full range of hearing extended from at least 0.1 to 60 kHz.

4.3.1.6 Threats to the Species

The primary threat to bearded seals is habitat loss due to climate warming and the subsequent loss of sea ice (Cameron et al. 2010). Ocean acidification may alter prey populations and other important aspects of marine ecosystems. But while ecosystem responses to climate change may result in changes in bearded seal prey availability, given their apparent dietary flexibility, this threat may be of lesser concern (Cameron et al. 2010).

From May 1, 2011 through December 31, 2016, the NMFS declared an Unusual Morality Events (UMEs) for bearded seals stranding at unusually high levels for undetermined causes in the Bering and Chukchi seas. An additional UME was declared for this population for undetermined causes in 2019, and the closure of this declaration is pending (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed March 2023). That said, documented diseases and parasites are currently of low concern as a threat to the population status, however environmental changes could lead to novel pathogens or new levels of virulence. Predation risk is considered low, however it is impossible to predict future predation risk with the reduction of sea ice escape platforms.

Few bearded seal mortalities were documented in the 1990s and 2000s from commercial fishing in the Bering Sea-Aleutian Island groundfish flatfish and pollock trawl fisheries (Allen and Angliss 2010, Cameron et al. 2010). Direct and indirect impacts of bottom trawling on the fish and bethic communities may occur, but bearded seals reliance on groundfish species is relatively plastic, making them fairly adaptable. Moreover, since 2009, modified trawl gear has been required to keep gear elevated off the sea floor reducing effects on infauna (NMFS 2009, Cameron et al. 2010).

The current vessel operating season along the Northwest Passage is short – generally from late July to mid-October – and depends on the ice conditions in any given year (Arctic Council 2009), and only icebreakers and certain polar-class vessels are able to transit the typical pack-ice habitat of bearded seals (Cameron et al. 2010). However, this may change with diminishing ice in the spring increasing vessel traffic during seals' whelping and nursing period increasing the potential for disturbance during this sensitive time period, and increasing risk of exposure to pollutants such as oil and noise (Cameron et al. 2010). Pollution, such as that from an oil spill, is currently considered low in probability, but a high risk of impacts to individuals is likely should exposure to oil occur (Cameron et al. 2010). Noise disturbance is currently considered a relatively minor threat due to its highly variable and temporary nature.

Commercial harvesting of marine mammals has been prohibited in U.S. waters since 1972 by the MMPA (16 U.S.C. 1361 et seq.), but subsistence hunting by Alaska Native hunters is permitted (Cameron et al. 2010). Bearded seals are important food sources for subsistence communities in the Bering Strait region. Between 1990 and 1998, the mean levels of bearded seals harvested in all of Alaska peaked to 6,788 per year (Coffing et al. 1998, Georgette et al. 1998, Allen and Angliss 2010). Predictions are that if habitat in traditional hunting areas shift more offshore due to loss of sea ice or prey distribution shifts, seal densities may be lower and/or more distant, thus reducing the opportunity for harvest (Cameron 2010). Given the importance of bearded seals to subsistence, it is believed that any prolonged and large population declines may be evident from observations of hunters before they are detectable or quantifiable by scientific means. Nelson et al. (2019) determined the current level of harvest is sustainable.

4.3.2 Beringia DPS Bearded Seal Critical Habitat

In Alaska, critical habitat for bearded seal includes the areas outlined in **Figure 13**. The proposed action will occur within Beringia DPS bearded seal critical habitat. While NMFS determined the proposed action is not likely to adversely affect Beringia DPS bearded seal critical habitat, for purposes of understanding the current status of the species, a description if critical habitat is presented here.

The physical and Biological Features of critical habitat are:

1. Sea ice habitat suitable for whelping and nursing, which is defined as areas with waters 200 m or less in-depth containing pack ice of at least 25 percent concentration and providing bearded seals access to those waters from the ice.
2. Sea ice habitat suitable as a platform for molting, which is defined as areas with waters 200 m or less in-depth containing pack ice of at least 15 percent concentration and providing bearded seals access to those waters from the ice.
3. Primary prey resources to support bearded seals: Waters 200 m or less in depth containing benthic organisms, including epifaunal and infaunal invertebrates, and demersal fishes.

Figure 13. Beringia DPS bearded seal critical habitat.

4.3.3 Arctic Ringed Seal

4.3.3.1 Population Structure and Status

NMFS recognizes one stock of Arctic ringed seals, the Alaska stock, in U.S. waters, including the action area. The Arctic ringed seal was listed as threatened under the ESA, primarily due to expected impacts on the population from declines in sea ice and snow cover stemming from climate change within the foreseeable future. NMFS has not prepared a Recovery Plan for the Arctic subspecies of ringed seal.

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

Conn et al. (2014) used a sub-sample of the data collected from the U.S. portion of the Bering Sea in 2012, and calculated an abundance estimate of 171,418 ringed seals (95% CI: 141,588-201,090). This estimate did not account for availability bias due to seals in the water at the time of the surveys and, like Boveng et al. (2017b), noted that these estimates should be viewed with caution because a single point estimate of availability (haul-out correction factor) was used and the estimates did not include ringed seals in the shorefast ice zone. It has been stated that the actual number of ringed seals in the U.S. portion of the Bering Sea is likely much higher, perhaps by a factor of two or more (Muto et al. 2020). However, due to the lack of precise population estimates, the population trends for the Arctic subspecies and Alaska stock are unknown.

4.3.3.2 Distribution

Arctic ringed seals have a circumpolar distribution and are found throughout the Arctic basin and in adjacent seasonally ice-covered seas. They remain with the ice most of the year and use it as a haul-out platform for resting, pupping, and nursing in late winter to early spring, and molting in late spring to early summer. During summer, ringed seals range hundreds to thousands of km to forage along ice edges or in highly productive open-water areas (Harwood and Stirling 1992, Freitas et al. 2008, Kelly et al. 2010b, Harwood et al. 2015).

4.3.3.3 Occurrence in the Action Area

In Alaskan waters, during winter and early spring when sea ice is at its maximal extent, ringed seals are abundant in the northern Bering Sea, Norton and Kotzebue Sounds, and throughout the Chukchi and Beaufort seas (Boveng et al. 2017b). When the ice breaks up, most ringed seals head north with the ice (Oceana and Kawerak 2014).

In spring, Nome hunters look for ringed seals between Nome and Sledge Island, and around Cape Nome because the first open water occurs there (Oceana and Kawerak 2014). During summer, ringed seals reportedly concentrate around Sledge Island and near the mouth of the Sinuk River, approximately 20 nm west of Port of Nome (Oceana and Kawerak 2014). Crawford et al. (2012) documented movements of ringed seal adults and 14 subadults that were captured in Kotzebue Sound to the north of Norton Sound, and tagged with satellite transmitters. The recorded subadult ringed seals moved through the action area in June as they followed the coastline north to the Chukchi Sea (**Figure 14**). A few ringed seals have also been noted in summer at the mouth of salmon bearing streams such as Nome River, between Port of Nome and Cape Nome. Finally, surveys conducted by the USACE at Port of Nome during 154 hours of observation in July, August, September and October of 2019 and 2021, recorded no ringed seals (USACE, unpublished data, 2023).

Published data on ringed seal density in the Norton Sound region is lacking. Expanding the spatial range to the Bering Sea, a survey conducted in 1976 reports ringed seal density ranging from 0.005-0.017 animals/kilometer squared Braham et al. 1984). NMFS considers these data the best available information, and using the upper range of the reported density, we assume ringed seals occur in the project area at a density of 0.02 animals/kilometer squared.

4.3.3.4 Feeding, Diving, Hauling Out and Social Behavior

Ringed seal pups are born and nursed in the spring (March through May), normally in subnivean birth lairs, with the peak of pupping occurring in early April (Frost and Lowry 1981). Subnivean lairs provide thermal protection from cold temperatures, including wind chill effects, and some protection from predators (Smith and Stirling 1975, Smith 1976). These lairs are especially important for protecting pups. Arctic ringed seals appear to favor shore-fast ice for whelping habitat. Ringed seal whelping has also been observed on both nearshore and offshore drifting pack ice (e.g., Lentfer 1972). Seal mothers continue to forage throughout lactation, and move young pups between lairs within their network of lairs. The pups spend time learning diving skills, using multiple breathing holes, and nursing and resting in lairs (Smith and Lydersen 1991, Lydersen and Hammill 1993). After a 5 to 8 week lactation period, pups are weaned (Lydersen and Hammill 1993, Lydersen and Kovacs 1999). Mating is thought to take place under the ice in the vicinity of birth lairs while mature females are still lactating (Kelly et al. 2010a). The sex ratio is even to slightly male dominated (Smith 1970, Quakenbush et al. 2011b). Ringed seals undergo an annual molt (shedding and regrowth of hair and skin) that occurs between mid-May to mid-July, during which time they spend many hours hauled out on the ice (Reeves 1998). The relatively long periods of time that ringed seals spend out of the water during the molt have been ascribed to the need to maintain elevated skin temperatures during new hair growth (Feltz and Fay 1966).

Ringed seals tend to haul out of the water during the daytime and dive at night during the spring to early summer breeding and molting periods, while the inverse tended to be true during the late

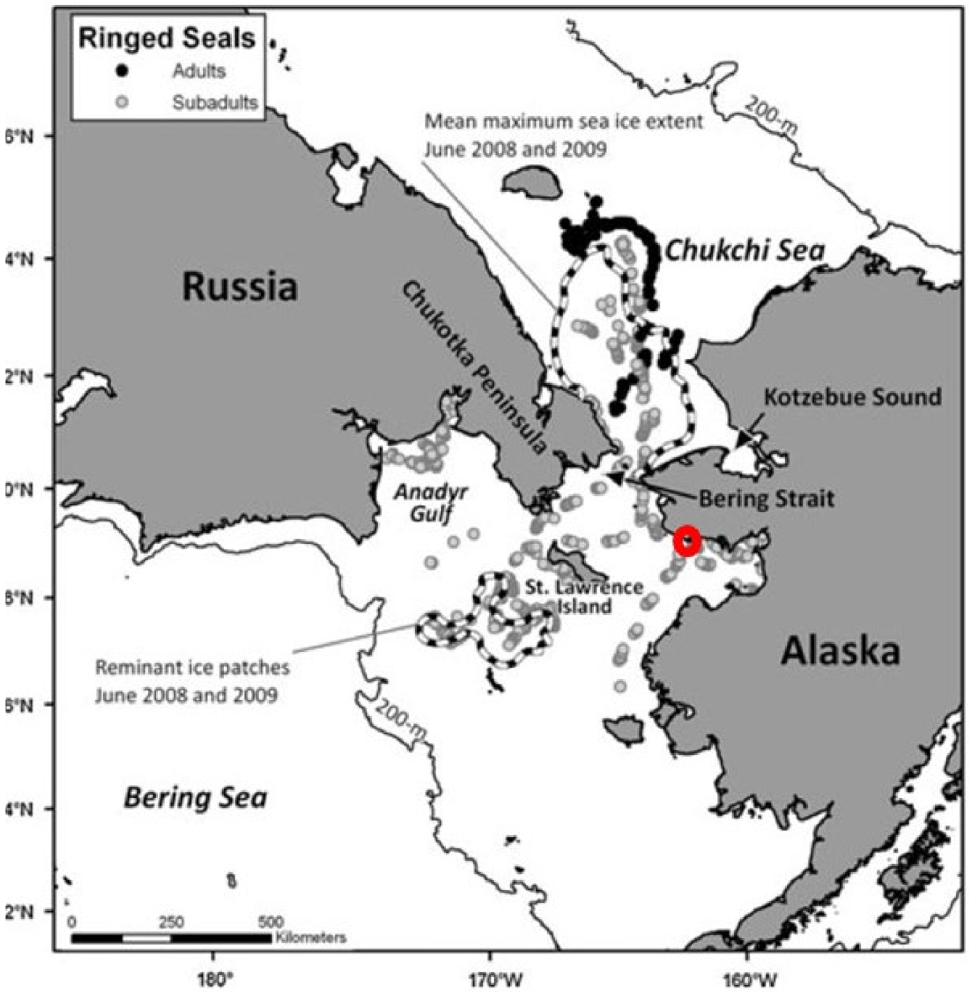

Figure 14. Summer distribution of satellite tagged ringed seals (1 adult, 5 sub-adults) during 2008 and 2009 (Crawford et al. 2012). Proposed action construction area circled in red.

summer, fall, and winter (Kelly and Quakenbush 1990, Lydersen 1991, Teilmann et al. 1999, Carlens et al. 2006, Kelly et al. 2010a, Kelly et al. 2010b). Diel activity patterns suggested greater allocation of foraging efforts in midday hours (Von Duyke et al. 2020). Haul-out patterns were complementary, occurring mostly at night until April-May, when midday hours were preferred (Von Duyke et al. 2020).

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

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

Tagging studies revealed that Arctic ringed seals are capable of diving for at least 39 minutes (Teilmann et al. 1999) and to depths of over 500 m (Born et al. 2004); however, most dives reportedly lasted less than 10 minutes and dive depths were highly variable (Kelly and Wartzok 1996, Teilmann et al. 1999, Gjertz et al. 2000).

4.3.3.5 Vocalization, Hearing, and Other Sensory Capabilities

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

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

4.3.3.6 Threats to Species

The principal threat to ringed seals is increased juvenile mortality from hypothermia and predation (Kelly et al. 2010b). The ultimate cause for the increased threat is habitat alteration stemming from climate change (NMFS 2012). Ringed seals depend on ice as a platform for resting, whelping, nursing, and molting, and they depend on snow cover to provide protection from cold and predators. Ice and snow cover are changing and will continue to do so as the climate warms. Model projections for the Eastern Bering Sea suggest little change in sea ice extent is expected to the end of this century, and the largest decline in sea ice extent is projected to occur during the months of November and December (Cameron et al. 2010). However, by mid-century and beyond, April snow depths are forecasted to be less than 5 centimeters throughout the Bering Sea. Ringed seals, especially newborns, depend on snow cover for protection from cold temperatures and predators. Reduced snowfall results in less snow accumulation next to pressure ridges where lairs occur, leaving pups more vulnerable to predation compared to pups in lairs with thicker snow cover (Hammill and Smith 1989, Ferguson et al. 2005). Furthermore, warming temperatures that melt snow-covered birth lairs may result in pups being exposed to ambient conditions and suffering from hypothermia (Stirling and Smith 2004). When lack of snow cover forces birthing to occur in the open, nearly 100% of pups die from predation (Lydersen et al. 1987, Lydersen and Smith 1989, Smith et al. 1991, Smith and Lydersen 1991).

Although no scientific studies have directly addressed the impacts of ocean acidification on ringed seals, the effects will likely impact their ability to find food due to declines in phytoplankton concentrations (Boyce et al. 2010), and shifts in community organization and productivity in the Bering Sea (Grebmeier et al. 2006, Litzow et al. 2006, Laurel et al. 2021). But while ocean acidification is likely to have increasingly profound impacts on ecosystem structure in the ringed seal habitats, the exact nature of these impacts cannot be predicted.

Not all potential threats to ringed seals are climate related. While NMFS considers the potential threat of disease to ringed seals as low risk, abiotic and biotic changes to ringed seal habitat potentially could lead to exposure to new pathogens or new levels of virulence (NMFS 2012). Ringed seals have tested positive for phocine morbillivirus (i.e., distemper), which has caused mass mortality in European harbor seals. Thus, distemper may be considered a threat to ringed seals. But the foreseeability of an inherently episodic and novel threat is difficult or impossible to establish. From May 1, 2011 through December 31, 2016, the NMFS declared an UME for ringed seals stranding at unusually high levels for undetermined causes in the Bering and Chukchi seas. An additional UME was declared for this population for undetermined causes in 2019, and the closure of this declaration is pending (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed March 2023).

Ringed seals are commonly preyed upon by polar bears and Arctic foxes, and less commonly by other terrestrial carnivores, sharks, and killer whales. While polar bears are the primary predator of ringed seals, and can impact a high proportion of pups born each year, predation on newborn pups by gulls and ravens also occurs. As previously mentioned, predation of pups is typically prevented by the pups' concealment in subnivean lairs. When the pups are prematurely exposed, however, predation by birds, as well as terrestrial carnivores, can be substantial (Kelly et al. 2010b).

Ringed seals remain an important subsistence resource for many northern coastal communities, and at this time harvest levels appear sustainable (NMFS 2012). Commercial harvest of Arctic ringed seals in the U.S. is unlawful under the MMPA and therefore does not occur. Overutilization through harvest (e.g., subsistence, illegal, sport and commercial, scientific) is considered low risk (Kelly et al. 2010b).

Physical and noise disturbance from marine activities within the range of Arctic ringed seals is believed to be low risk. Such disturbances and threats may occur from man-made factors such as contaminants entering the marine environment, vessels, commercial fisheries, and oil and gas development.

4.3.4 Arctic Ringed Seal Critical Habitat

In Alaska, critical habitat for ringed seal includes the following areas outlined in Figure 15. The proposed action is within Arctic ringed seal critical habitat. While NMFS determined the proposed action is not likely to adversely affect Arctic ringed seal critical habitat, for purposes of understanding the current status of the species, a description if critical habitat is presented here. The PBFs of Arctic ringed seal critical habitat are:

1. Snow-covered sea ice habitat suitable for the formation and maintenance of subnivean birth lairs used for sheltering pups during whelping and nursing, which is defined as waters 3 m or more in depth, relative to MLLW, containing areas of seasonal landfast (shorefast) ice or dense, stable pack ice, that have undergone deformation and contain snowdrifts of sufficient depth to form and maintain birth lairs (typically at least 54 cm deep);

2. Sea ice habitat suitable as a platform for basking and molting, which is defined as areas containing sea ice of 15 percent or more concentration in waters 3 m or more in depth (relative to MLLW);

3. Primary prey resources to support Arctic ringed seals, which are defined to be small, often schooling, fishes, in particular Arctic cod, saffron cod, and rainbow smelt (*Osmerus mordax*), as well as small crustaceans, in particular, shrimps and amphipods.

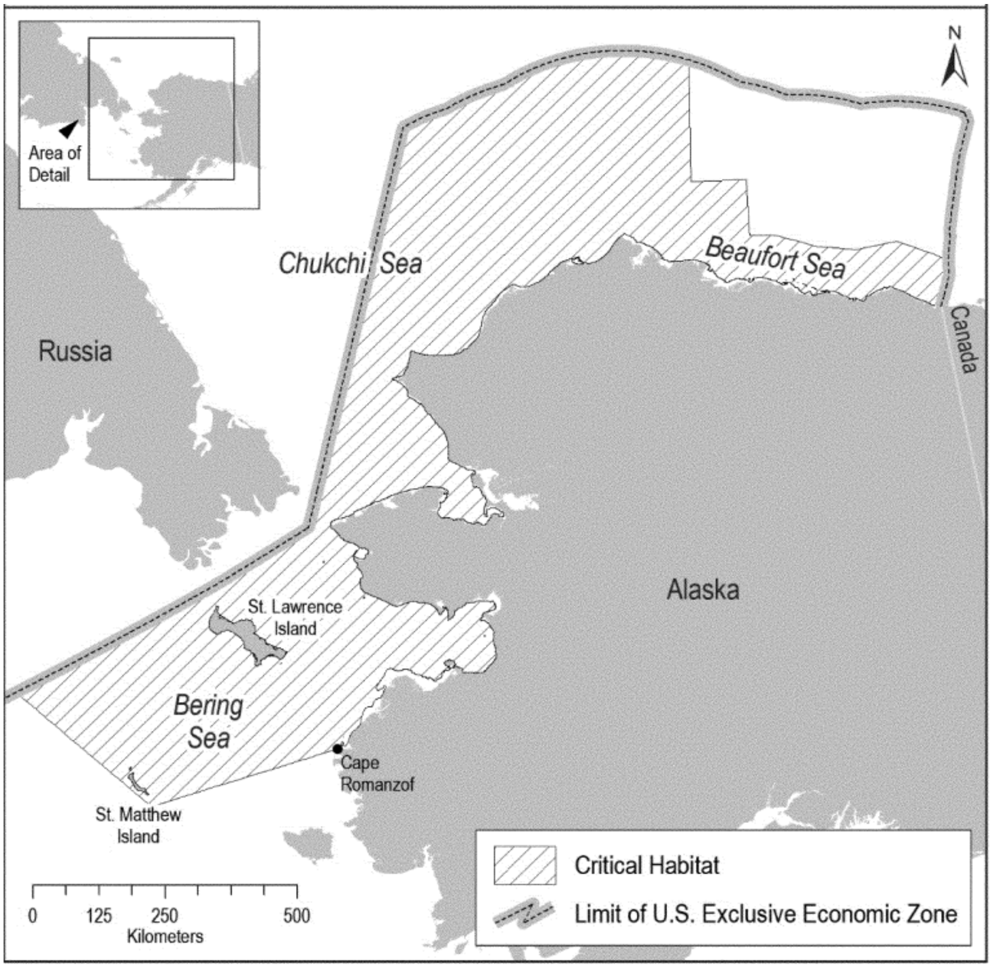

Figure 15. Arctic ringed seal critical habitat

4.3.5 Western DPS Steller Sea Lion

4.3.5.1 Population Structure and Status

Steller sea lions were 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 (62 FR 24345; May 5, 1997); the eastern DPS was listed as threatened and the Western DPS was listed as endangered. On November 4, 2013, 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 2008) and 5-year Status Review (NMFS 2020a).

The Western DPS of Steller sea lions decreased from an estimated 220,000 to 265,000 animals in the late 1970s to fewer than 50,000 in 2000 (Muto et al. 2021). Factors that may have contributed to this decline include incidental take in fisheries, competition with fisheries for prey, legal and illegal shooting, predation, exposure to contaminants, disease, and ocean regime shift-driven climate change (NMFS 2008). The most recent comprehensive aerial photographic and land-based surveys of Western DPS Steller sea lions estimated a total Alaska population (both pups and non-pups) of 52,932 (Muto et al. 2021). 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 Aleutian Islands and generally negative trends in the central and western Aleutian Islands.

Pup counts declined in the eastern and central Gulf of Alaska between 2015 and 2017, counter to the increases observed in both regions since 2002 (Sweeney et al. 2017). These declines may have been due to changes in prey availability from the marine heatwave that occurred in the northern Gulf of Alaska from 2014 to 2016 (Bond et al. 2015, Petersen et al. 2016, Muto et al. 2021). Pup counts rebounded to 2015 levels in 2019; however, non-pup counts in the eastern, central, and western Gulf of Alaska regions declined (Muto et al. 2021).

4.3.5.2 Distribution

Steller sea lions are distributed along the rim of the North Pacific Ocean from San Miguel Island (Channel Islands) off Southern California to northern Hokkaido, Japan (Loughlin et al. 1984). Their centers of abundance and distribution are in Gulf of Alaska and the Aleutian Islands (NMFS 1992; **Figure 16**).

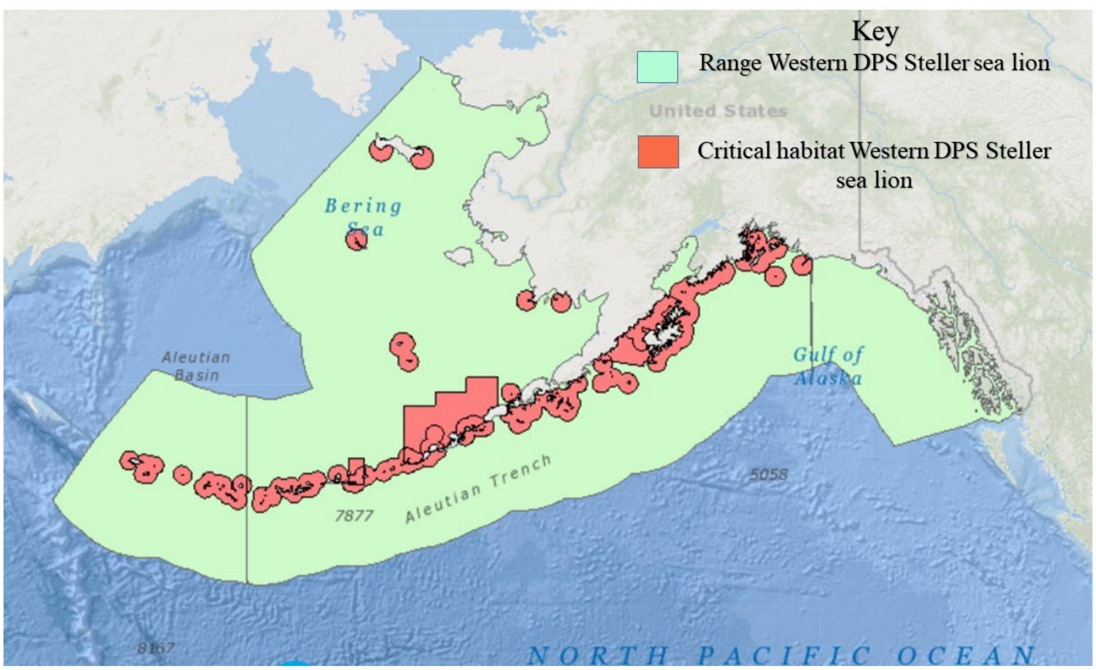

Figure 16. Range of Western DPS Steller sea lions, and haulouts, rookeries, and important aquatic areas designated as critical habitat.

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). In the Bering Sea, the northernmost major rookery is on Walrus Island in the Pribilof Island group. The northernmost major haul-out is on Hall Island off the northwestern tip of St. Matthew Island. Their distribution also extends northward from the western end of the Aleutian Chain to sites along the eastern shore of the Kamchatka Peninsula.

Individual Steller sea lions move between rookeries and haul out sites regularly (Calkins and Pitcher 1982, Raum-Suryan et al. 2002, Raum-Suryan et al. 2004). Most adult Steller sea lions occupy rookeries during the summer pupping and breeding season and exhibit a high level of site fidelity. 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). After breeding season, adult males may disperse widely (Calkins and Pitcher 1982, Calkins 1986, Loughlin 1997). During fall and winter many sea lions disperse from rookeries and increase use of haulouts, particularly on terrestrial sites but also on sea ice in the Bering Sea.

4.3.5.3 Occurrence in the Action Area

NMFS expects some level of occurrence in the action area during the open water season, given the wide dispersal of Steller sea lions. However, Norton Sound approaches the northernmost extent of their known range. NMFS assumes all Steller sea lions in the action area are all from the Western DPS.

Little published or unpublished information exists regarding occurrence of Steller sea lions in the Norton Sound region. No Steller sea lions were observed during the 2019 and 2021 survey (154 hours of observation), during summer and fall months within the action area (USACE, unpublished data, 2023). During shipboard monitoring associated with a cable laying operation offshore of Nome in early July, 2017, two Steller sea lion observations were made (Green et al. 2018). Both observations occurred when the vessel was offshore more than 50 nm in the Bering Strait. Steller sea lions are occasionally seen hauled out on Sledge Island (approximately 20 nm northwest of Port of Nome (Oceana and Kawerak 2014). Furthermore, the USACE stated, in a 2012 Environmental Assessment for dredging in the Port of Nome that Steller sea lions might rarely be found in the area (USACE 2012). In a summary of marine mammals used as subsistence resources by the local communities of the Bering Strait region (including Nome), Steller sea lions are not mentioned as they are not an important subsistence hunting species in the region (Georgette et al. 1998, Oceana and Kawerak 2014).

Given their irregular and intermittent occurrence in the action area, we assume Steller sea lions are in the vicinity of the proposed project area to feed during open water season at a rate of 1 individual per day.

4.3.5.4 Feeding, Diving, Hauling Out and Social Behavior

Steller sea lions are generalist predators that eat various fish: arrowtooth flounder (*Atheresthes* *stomias*), rockfish (*Sebastes* sp.), hake (*Merluccius* sp.), flatfish, Pacific salmon (*Oncorhynchus* sp.), Pacific herring (*Clupea pallasii*), Pacific cod, sandlance, skates, cusk eel, lamprey, walleye pollock, Atka mackerel (*Pleurogrammus monopterygius*), squids and octopus and occasionally birds and marine mammals (Pitcher 1981, Pitcher and Fay 1982, Calkins and Goodwin 1988, Sinclair and Zeppelin 2002, Trites et al. 2007, McKenzie and Wynne 2008, Womble and Conlon 2010). Diet is likely strongly influenced by local and temporal changes in prey distribution and abundance (McKenzie and Wynne 2008, Sigler et al. 2009, Sigler et al. 2017). Haulout selection appears to be driven at least in part by local prey density (Winter et al. 2009).

Foraging generally occurs within 8 to 24 km of shore (Fiscus and Baines 1966), but it can occur hundreds of km from shore over extended periods (Merrick et al. 1997, Merrick and Loughlin 1997). Summer foraging dives tend to be closer to shore (about 16 km) and shallower (100-250 m (Merrick and Loughlin 1997, Loughlin 2002).

Foraging activity is highly variable in Steller sea lions by sex and season. Adult males rarely or never eat while on breeding grounds (Loughlin 2002). During breeding season, females tend to feed at night on one to two day trips and return to nurse pups (NRC 2003). Mothers with newborn pups will make their first foraging trip about a week after giving birth, but trips are short in duration and distance at first, then increase as the pup gets older (Merrick and Loughlin 1997, Pitcher et al. 2001, Maniscalco et al. 2006). Females attending pups tend to stay within 37 km of the rookery (Calkins 1996, Merrick and Loughlin 1997). Newborn pups are wholly dependent upon their mother for milk during at least their first three months of life (Trites et al. 2006). During winter female Steller sea lion foraging trips are longer (130 km) and dives are deeper (frequently greater than 250 m). As pups mature and start foraging for themselves, they develop greater diving ability until roughly 10 years of age (Pitcher et al. 2005). Juveniles usually make shallow dives of 70 to 140 m over 1 to 2 minutes, but much deeper dives in excess of 300 m are known (Merrick and Loughlin 1997, Loughlin et al. 2003, Pitcher et al. 2005). Young animals also tend to stay in shallower water less than 100 m deep and within 20 km from shore (Fadely et al. 2005).

4.3.5.5 Vocalization, Hearing, and Other Sensory Capabilities

Males and females apparently have different hearing sensitivities, with males hearing best at 1 to 16 kHz (best sensitivity at the low end of the range) and females hearing from 16 to 25 kHz (best hearing at the upper end of the range; (Kastelein et al. 2005)).

To facilitate the acoustic effects analyses, marine mammals were divided into functional hearing groups (based on their hearing range), and the same criteria and thresholds were used for all species within a group. Steller sea lions are part of the Otariid group, with hearing limits estimated to be 100 Hz to 50 kHz in water (Finneran and Jenkins 2012).

4.3.5.6 Threats to Species

Primary threats to the Western DPS Steller sea lions include environmental variability, competition with fisheries, and predation by killer whales (NMFS 2008). Periodic shifts in oceanic and atmospheric conditions may have major effects on the productivity and structure of

North Pacific ecosystems, with cascading effects on some prey fish populations (NMFS 2008). Adult female and juvenile Steller sea lions are likely the most vulnerable age-classes to succumb to this threat.

Understanding how changing environmental conditions affect the distribution and abundance of non-commercial, forage fish, and subsequently the foraging ecology of sea lions, is critical to assessing sea lion's health and condition (NMFS 2008). Large scale shifts in oceanographic conditions, including ocean circulation, distribution of gyres, stratification, nutrient input, pH, and temperature shifts, could potentially disrupt trophic pathways (Doney et al. 2012, Salinger et al. 2013). These shifts may have large impacts on the ability of Steller sea lions to forage efficiently (NMFS 2020).

Large scale fisheries may impact the temporal and spatial patterns of abundance and nutritional value of Steller sea lions prey (NMFS 2020a), although between 2013 and 2017, 36 Western DPS Steller sea lions were killed or seriously injured in U.S. commercial fisheries (Muto et al. 2020). The primary concern, however, centers on the potential for fisheries to reduce sea lion prey biomass and quality that may lead to a reduction in sea lion survival and reproduction. However, due to a myriad of factors the impact of fisheries on sea lion prey still is not sufficient to conclude whether fisheries are limiting their recovery (NMFS 2020).

The Recovery Plan (NMFS 2008) ranked predation by killer whales (*Orcinus orca*) among the top threats that may impede the recovery of the Western DPS Steller sea lion. Transient (a.k.a. Biggs) killer whales are known to prey upon marine mammals and they occur in the Bering Sea, although their abundance there is unknown (Muto et al. 2021). Although predation by killer whales has been documented in Alaska (Loughlin and York 2000, Maniscalco et al. 2007), NMFS has concluded that there is inadequate data to assess the threat of predation to the recovery of Steller sea lions (NMFS 2020a).

Of lower concern are exposures to toxins, interactions with fishing gear, harvest (both subsistence and illegal), entanglement in marine debris, disease, and disturbance from vessels (NMFS 2008). An attraction to harbors may increase Steller sea lion's vulnerability to ship-strikes. However this threat is not considered significant.

Steller sea lions are exposed to a variety of diseases and parasites and adult females and pups are likely the age-classes most vulnerable to disease and parasitism. Climate-related shifts in distribution of other species marine mammal species may expose the Western DPS Steller sea lions to novel disease vectors or parasites, which may have large-scale impacts. Increasing temperatures in the Arctic and subarctic waters lead to an increased potential for HABs that produce biotoxins (NMFS 2008). This threat is currently not regarded as one with population-level effects.

Adult females and pups are likely the age-classes most vulnerable to toxic substances, however, relatively low levels of toxic substances, including heavy metals, have been documented in Steller sea lions. Therefore, these substances are not believed to have caused high levels of mortality or reproductive failure (NMFS 2008). Oil spills could impact food web dynamics, but at present, this source of potential pollution is not believed to pose a significant risk to Western DPS Steller sea lions (NMFS 2020). The persistence of organochlorine contamination in the environment and the associated serious health risks could impact Western DPS Steller sea lions. The widespread use of these compounds has been associated with deleterious effects on the health and condition of pinnipeds including reduced pup production, premature parturition, altered immune function (de Swart et al. 1996; Beckmen et al. 2003), and cancer (Ylitalo et al. 2005; Randhawa et al. 2015; Deming et al. 2018). While the effects of organochlorine exposure have been studied widely on California sea lions (*Zalophus californianus*) (Gulland et al. 1996; Greig et al. 2005; Ylitalo et al. 2005; Randhawa et al. 2015; Deming et al. 2018), the potential risks to Steller sea lions is not well understood (NMFS 2020).

Although the Steller Sea Lion Recovery Plan (NMFS 2008) ranked interactions with fishing gear and marine debris as a low threat to the recovery of the Western DPS, it is likely that many entangled sea lions may be unable to swim to shore once entangled, may die at sea, and may not be counted (Loughlin 1986; Raum-Suryan et al. 2009). Therefore, the severity of this threat is unknown.

Males, both juvenile and adult, are the demographic group most vulnerable to subsistence harvests (NMFS 2008). While sea lions are important subsistence resources in some communities, such as St. Paul Island, they do not typically occur in the Bering Strait region, so those communities rely on other more abundant marine mammal species (Malek and Cornish 2019). Sea lion-specific regulations promulgated under the MMPA (50 CFR 224.103(d)(1)(i)) prohibit the discharge of firearms near Steller sea lions, which has likely reduced the amount of illegal shooting. However, illegal shooting still occurs (Wright 2016, 2021).

The response of sea lions to vessel traffic depends on the location of the disturbance, the season, age class, and the stage of reproduction (NMFS 2008). Pups are the age-class most vulnerable to disturbance. Avoidance of rookeries and haulouts should result in minimal response, although low levels of occasional disturbance could have long-term effects.

4.3.5.7 Western DPS Steller Sea Lion Critical Habitat

NMFS designated critical habitat for Steller sea lions on August 27, 1993 (58 FR 45269). In Alaska, designated critical habitat includes the following areas as described at 50 CFR § 226.202. (Figure 17). While NMFS determined the proposed action is not likely to adversely affect Steller sea lion critical habitat (Section 4.1.4), for purposes of understanding the current status of the species, a description if critical habitat is presented here.

1. Terrestrial zones that extend 3,000 feet (0.9 km) landward from each major haulout and major rookery in Alaska.
2. Air zones that extend 3,000 feet (0.9 km) above the terrestrial zone of each major haulout and major rookery in Alaska.
3. Aquatic zones that extend 3,000 feet (0.9 km) seaward of each major haulout and major rookery in Alaska that is east of 144° W longitude.

4. Aquatic zones that extend 20 nm (37 km) seaward of each major haulout and major rookery in Alaska that is west of 144° W longitude.
5. Three special aquatic foraging areas: the Shelikof Strait area, the Bogoslof area, and the Seguam Pass area, as specified at 50 CFR § 226.202(c).

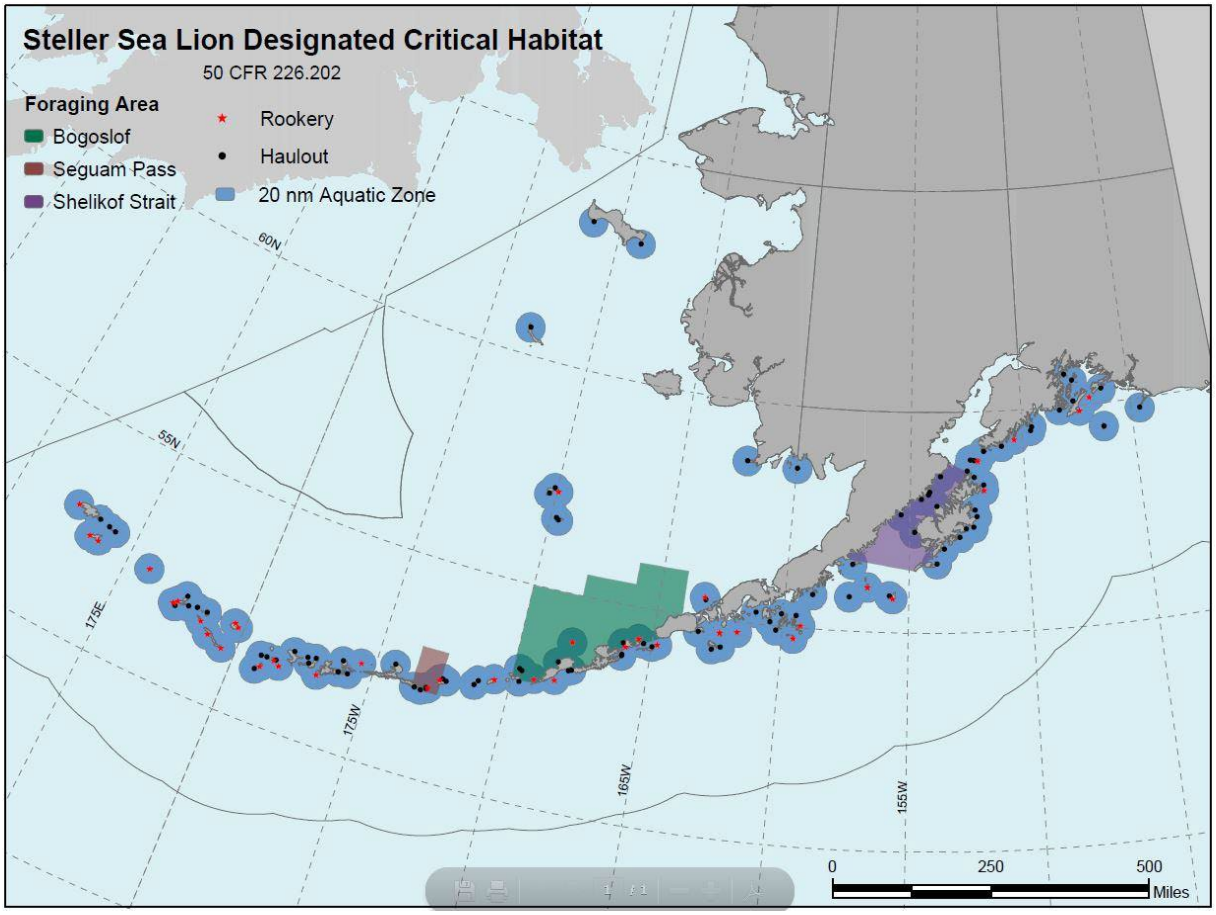

Figure 17. Designated Steller sea lion critical habitat in Alaska.

4.3.6 Bowhead Whale

4.3.6.1 Status and Population Structure

The bowhead whale (*Balaena mysticetus*) was listed as endangered under the Endangered Species Conservation Act (ESCA) in 1970 (35 FR 8491, June 2, 1970 (baleen whales listing); 35 FR 18319, December 2, 1970 (bowhead whales)), and continued to be listed as endangered following passage of the ESA. The only bowhead whale stock found in U.S. waters is the Western Arctic stock. Western Arctic bowhead whales are distributed in seasonally ice-covered waters of the Arctic and near-Arctic, generally north of 60°N and south of 75°N. Critical habitat has not been designated for the bowhead whale.

The most recent estimates of abundance for this stock were made in 2019; an ice-based survey estimated 14,025 (CV = 0.228) whales (Givens et al. 2021) while an aerial survey estimated 17,175 (CV = 0.237; Ferguson et al. 2022). The population has steadily increased in abundance since the 1980s (Givens et al. 2021) and may be approaching carrying capacity (Citta et al. 2023).

4.3.6.2 Distribution

In Alaska, the majority of bowhead whales migrate annually from northern Bering Sea wintering areas (December to March), through the Chukchi Sea in spring (April to May), to the Beaufort Sea, where they spend much of the summer (June through early to mid-October) before returning to Bering Sea wintering areas in fall (September through December; Citta et al. 2020) (Figure 18). A shift after 2012–2013 shows some bowheads are remaining in southern Chukchi Sea rather than moving through the Bering Strait and into the northwestern Bering Sea for the winter (Citta et al. 2023, Szesciorka and Stafford 2023). Spring northward migration into the southern Chukchi Sea was earlier in years with less mean January–March Chukchi Sea ice area and delayed in years with greater sea ice area. As sea ice continues to decline, northward spring-time migration could shift earlier or more bowhead whales may overwinter at summer feeding grounds (Szesciorka and Stafford 2023).

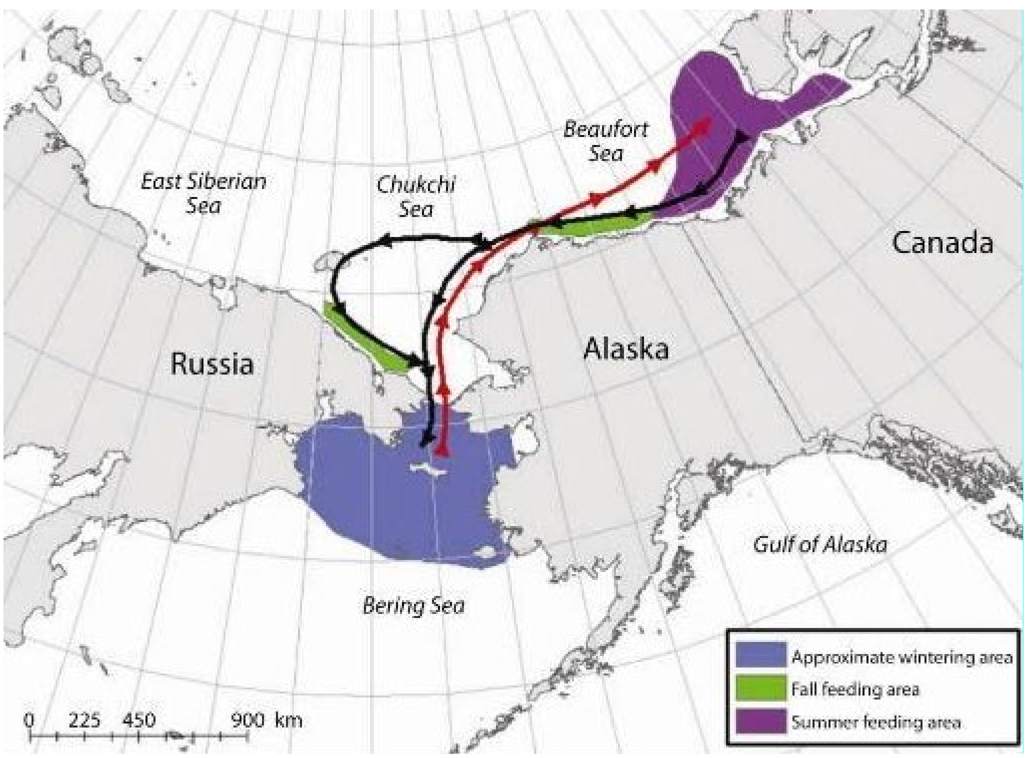

Figure 18. Generalized migration route, feeding areas, and wintering area for Western Arctic bowhead whale (Moore and Laidre 2006).

4.3.6.3 Occurrence in the Action Area

The vast majority of the bowhead whales migrate through the Bering Strait in the spring (April to May) and spend the summer and fall in the Beaufort and Chukchi seas and do not pass south through the Bering Strait until ice is forming in the fall (Moore and Laidre 2006, Clarke et al. 2015, Clarke et al. 2020, Brower et al. 2022b). During the eastward (spring) migration, the whales are distributed farther offshore. While a few whales may occur in the Central Beaufort Sea area throughout the summer, most of the population spends the summer in the eastern Beaufort Sea before passing through again during the latter part of summer and fall as they migrate west to over winter in the Bering Sea. Bowhead whales are most likely to be encountered during the fall migration when they travel closer to shore in water ranging from 15 to 200 m deep (50 to 656 ft) (Miller et al. 2002, Clarke et al. 2012, Clarke et al. 2020, Brower et al. 2022a).

The Alaska Eskimo Whaling Commission represents the communities that have long depended on the bowhead whale for food and traditional practices. These coastal communities are located where bowhead whales regularly and reliably pass near their villages. Nome is not one of these communities. Although bowhead whales may on occasion be seen in Norton Sound (Austin Ahmasuk pers. comm. 2023), from the collective information from the scientific literature and the coastal villages, presence of bowheads during the open water season in Norton Sound is likely an unusual event, not a regular or typical one.

4.3.6.4 Feeding

Evidence suggests that bowhead whales feed on concentrations of zooplankton throughout their range (Muto et al. 2019). Bowheads are filter feeders, straining prey from the water through baleen (Lowry 1993, Werth and Sformo 2021). They feed throughout the water column, including bottom feeding as well as skim feeding near the surface (Würsig et al. 1989). Skim feeding can occur when animals are alone or may occur in coordinated echelon formations of over a dozen animals (Würsig et al. 1989). Bowhead whales typically spend a high proportion of time on or near the ocean floor. Even when traveling, bowhead whales visit the bottom on a regular basis (Quakenbush et al. 2010). Laidre et al. (2007) and others have identified krill concentrated near the sea bottom, and bowhead whales have been observed with mud on their heads and bodies and streaming from their mouths (Mocklin 2009). Food items most commonly found in the stomachs of harvested bowheads include euphausiids, copepods, mysids, and amphipods (Lowry et al. 2004, Moore et al. 2010). Euphausiids and copepods are thought to be their primary prey. Lowry et al. (2004) documented that other crustaceans and fish also were eaten but were minor components in samples consisting mostly of copepods or euphausiids.

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

4.3.6.5 Hearing, Vocalizations, and Other Sensory Abilities

Bowhead whales are among the more vocal of the baleen whales (Clark and Johnson 1984). Most underwater calls are at a fairly low frequency and easily audible to the human ear. Vocalization is made up of moans of varying pitch, intensity and duration, and occasionally higher-frequency screeches. Bowhead whale songs have a bandwidth of 20 to 5000 Hz with the dominant frequency at approximately 500 Hz and duration lasting from 1 minute to hours. Pulsive vocalizations range between 25 and 3,500 Hz and lasts 0.3 to 7.2 seconds (Wursig and Clark 1993, Erbe 2002, George et al. 2004).

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

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

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

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

4.3.6.6 Threats

A recovery plan has not been written for bowhead whales and consequently threats to the species have not been concisely articulated. The absence of commercial whaling has allowed the population to increase, and subsistence harvest is well managed and sustainable. The primary threats are likely from changes to the Arctic ecosystem that are occurring with climate change. These include changes in the amount, timing, and location of sea ice which may favor increased presence of killer whales (Willoughby et al. 2020), increased vessel traffic (Melia et al. 2016) with increased noise and strike risk (Halliday et al. 2022), a shift of commercial fishing to the north which would increase entanglement risk, and changes in the prey base caused by increased ocean temperatures or ocean acidification. Currently the population is stable or increasing (Givens et al. 2021). However, Citta et al. (2023) found that post-weaning bowhead whales had a statistically significant decline in body condition, which could be due to changes in sea ice or could reflect negative density dependence given increases in whale abundance and density.

5 ENVIRONMENTAL BASELINE

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

This section discusses the environmental baseline, focusing on existing anthropogenic and natural activities within and near the action area and their influences on listed species may be adversely affected by the proposed action. Species that may be affected by the proposed action include the bowhead whale, Western DPS Steller sea lions, Beringia DPS bearded seals, and Arctic ringed seals. 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.

5.1 Climate Change

All areas of the action area are being affected by climate change. Although the species living in the Arctic successfully adapted to changes in the climate in the past, the current rate of change is accelerated (Simmonds and Eliott. 2009). As described in Section 4.2, effects to Arctic ecosystems are very pronounced, wide-spread, and well documented. While a changing climate may create opportunities for range expansion for some species, the life cycles and physiological requirements of many specialized polar species are closely linked to the annual cycles of sea ice and photoperiod and they may be less adaptable (Doney et al. 2009, Wassmann et al. 2011). Because the rate of change is occurring so quickly, the changes may exceed species' ability to adapt. Additionally, the loss of sea ice as a barrier increases the potential for further anthropogenic impacts as vessel traffic for transportation and tourism increases, resource extraction activities expand, and pathogens or disease have a path into newly ice-free regions.

As discussed in Section 4.2, the Arctic is warming at two or more times the global average. One consequence of the warming is a reduction in the length of the snow season (Figure 19). The depth and duration of snow cover are projected to continue to decline substantially throughout the range of the Arctic ringed seal, reducing the areas with suitable snow depths for their lairs by an estimated 70 percent by the end of this century (Hezel et al. 2012). It has been observed that the mean thickness of snow accumulating on sea ice has declined from approximately 22-35 cm in the western Arctic and 15-33 cm in the Beaufort and Chukchi Seas since the mid-1900s (Webster et al. 2014). A decrease in the availability of suitable sea ice conditions (including depth of snow on ice available for lair formation) may not only lead to high mortality of ringed seal pups but may also produce behavioral changes in seal populations (Loeng et al. 2005). The persistence of this species will likely be challenged as decreases in ice and, especially, snow cover lead to increased juvenile mortality from premature weaning, hypothermia, and predation (Kelly et al. 2010b).

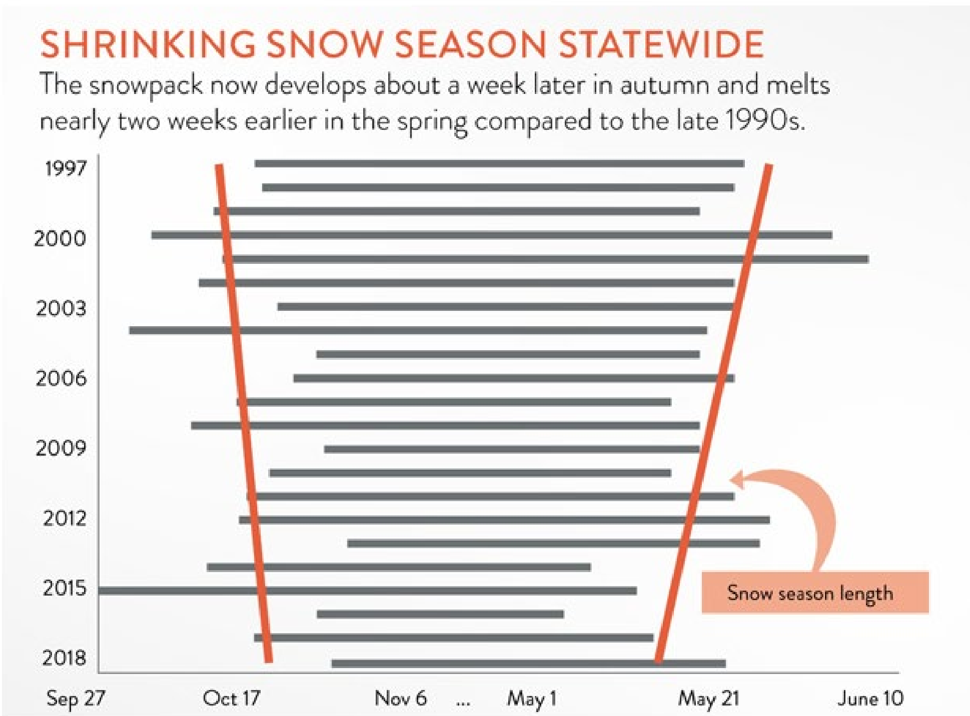

Figure 19. Length of the snow season (gray bars) in Alaska each year from 1997-2018. Orange slanting bars show the trends of the date when the state becomes 50 percent snow covered in fall and when half the winter snow has melted in spring. Image by Rick Thoman, Alaska Center for Climate and Policy.

Because the sea ice extent and thickness have been decreasing consistently, vessel traffic, and more importantly for seals, ice breaker traffic, is increasing in the Arctic (U.S. Committee on the Marine Transportation System 2019, NMFS 2020b). Although seals are maneuverable enough to avoid vessels in open water, icebreakers could be lethal to nursing pups through collisions or crushing by displaced ice (Wilson et al. 2017, Wilson et al. 2020). In a study of Caspian seals (*Pusa capsica)* from 2006-2013, Wilson et al. (2017) documented the response of seals to ice breakers that made regular transits across the Caspian Sea. The ice breaking route had high densities of breeding seals in most years. A whole range of impacts to mothers and their pups was documented including being struck by the ice breaker, moving away from the ice breaker as it approached, and having mothers and pups separated. Vessel passage may destroy birth sites, water access holes, and pup shelters replacing those features with brash ice or open water. Often pups were marooned on fragments of intact ice or wetted in brash ice. Fragmented brash ice may cause disorientation, stress, and increased energetic demands (Wilson et al. 2017). With the Northern Sea Route and Northwest Passage being available more often and an increase in icebreakers, we would expect that ice dependent seals could be affected.

With an earlier retreat of sea ice in the spring and warmer ocean temperatures (Section 4.2.1.2), there have been changes in the distribution of whales. Aerial surveys to study the distribution, relative abundance, and behavior of marine mammals have been conducted in the eastern Chukchi Sea, primarily during July through October, 1982–1991 and 2008–2016, for the Aerial Surveys of Arctic Marine Mammals (ASAMM) project and its precursors (Brower et al. 2018). Although historical records from commercial whaling and scientific research document humpback, fin, and minke whales from June through October in the western Chukchi Sea and near the Chukotka coast, few records of these subarctic species exist in the eastern Chukchi Sea (Clarke et al. 2013) and these species were entirely absent from this area in the 1982–1991 surveys (Brower et al. 2018). In contrast, there were 159 sightings of 250 individuals of these species in 2008–2016 in the eastern Chukchi Sea (Brower et al. 2018).

In addition to these observations, passive acoustic monitors (PAM) have been recording the presence of subarctic species in various parts of the Chukchi Sea (Delarue et al. 2013, Hannay et al. 2013, Crance et al. 2015, Tsujii et al. 2016, Stafford et al. 2022).These species generally arrive in the southern Chukchi Sea after the sea ice melts (late July) and leave before it extends over the area in October or early November (Hannay et al. 2013, Tsujii et al. 2016). PAM also recorded the farthest northeast record of fin whale calls in the Alaskan Arctic (Crance et al. 2015) and the extended use of the area by killer whales (Stafford et al. 2022). We would expect as sea ice continues to decline, presence of these subarctic species in more northerly latitudes will increase.

Shipping in the Arctic is expected to increase as sea ice decreases. Both major shipping routes, the Northern Sea Route along the northern Russian coast and the Northwest Passage through the Canadian Archipelago, pass through Bering Strait. The entire population of bowhead whales passes through the Bering Strait each spring and fall between wintering and summering areas (Quakenbush et al. 2012). There are about 33 km (20 mi) between the west side of the Diomedes Islands and the Chukotka coast. Ships traveling along the coast between October and December could encounter a high proportion of the bowhead population (Quakenbush et al. 2012). Ship strikes are the greatest source of mortality for North Atlantic right whales (*Eubalaena glacialis*) and bowhead and North Pacific right whales may be as vulnerable to ship strikes as North Atlantic right whales due to their swimming speed and feeding behavior (Reeves et al. 2012). Two percent of subsistence-harvested bowheads bear scars from vessel encounters (George et al. 2017). In addition, with the expansion of habitat by the subarctic species to the north, interactions with ship traffic in the Bering Strait is an area of concern for all species (Reeves et al. 2012).

Some Arctic species may benefit from some aspects of climate change. Conceptual models suggested that overall reductions in sea ice cover should increase the Western Arctic stock of bowhead whale prey availability (Moore and Laidre 2006). This theory may be substantiated by the steady increase in the Western Arctic bowhead population during the nearly 20 years of sea ice reductions (Walsh 2008). (George et al. 2006), showed that harvested bowheads had better body condition during years of light ice cover. Similarly, George et al. (2015) found an overall improvement in bowhead whale body condition and a positive correlation between body condition and summer sea ice loss over the last 2.5 decades in the Pacific Arctic. George et al. (2015) speculated that sea ice loss has positive effects on secondary trophic production within the Western Arctic bowhead whale's summer feeding region. Moore and Huntington (2008) anticipated that bowhead whales will alter migration routes and occupy new feeding areas in response to climate related environmental change.

5.1.1 Biotoxins

As temperatures in the Arctic waters warm and sea ice diminishes, marine mammal health may be compromised through nutritional and physiological stress, toxins from harmful algal blooms, and exposure to new pathogens. As mentioned in Section 4.2.1.2, an unprecedented harmful algal bloom extended from the Aleutian Islands to southern California as a result of the Pacific marine heatwave causing mass strandings of marine mammals (Cavole et al. 2016). Fey et al. (2015) found that across all animal taxa biotoxicity from harmful algal blooms was one of the events most often associated with mass mortality events. Two of the most common biotoxins along the West Coast of the Pacific are the neurotoxins domoic acid and saxitoxin (Lefebvre et al. 2016). Although these toxins can cause death, they can also cause sublethal effects including reproductive failure and chronic neurological disease (Broadwater et al. 2018).

Domoic acid was first recognized as a threat to marine mammal health in 1998 when hundreds of California sea lions (*Zalophus californianus*) died along beaches in central California or exhibited signs of neuroexcitotoxicity including seizures, head weaving, and ataxia (Scholin et al. 2000). Along the west coast of the United States and Canada, a coastwide bloom of the toxigenic diatom *Pseudo-nitzschia* in spring 2015 resulted in the largest recorded outbreak of domoic acid. Record-breaking concentrations of the marine neurotoxin caused unprecedented widespread closures of commercial and recreational shellfish and finfish fisheries and contributed to the stranding of numerous marine mammals along the U.S. west coast (McCabe et al. 2016).

Lefebvre et al. (2016) examined 13 species of marine mammals from Alaska including humpback whales, bowhead whales, beluga whales, harbor porpoises, northern fur seals, Steller sea lions, harbor seals, ringed seals, bearded seals, spotted seals, ribbon seals, Pacific walruses, and northern sea otters (Figure 20). Domoic acid was detected in all 13 species examined and had the greatest prevalence in bowhead whales (68%) and harbor seals (67%). Saxitoxin was detected in 10 of the 13 species, with the highest prevalence in humpback whales (50%) and bowhead whales (32%) and 5% of the animals tested had both toxins present (Lefebvre et al. 2016). It is not known if exposure to multiple toxins result in additive or synergistic effects or perhaps suppress immunity to make animals more vulnerable to secondary stressors (Broadwater et al. 2018). With declining sea ice, warmer water temperatures, and changes in ocean circulation patterns, NOAA anticipates that harmful algal blooms in the Arctic will likely worsen in the future[5].

Figure 20. Algal toxins detected in 13 species of marine mammals from southeast Alaska to the Arctic from 2004 to 2013 (Lefebvre et al. 2016). Marine mammal species are listed as follows: (A) humpback whales, (B) bowhead whales, (C) beluga whales, (D) harbor porpoises, (E) northern fur seals, (F) Steller sea lions, (G) harbor seals, (H) ringed seals, (I) bearded seals, (J) spotted seals, (K) ribbon seals, (L) Pacific walruses and (M) northern sea otters.

5.1.2 Disease

In addition to influencing animal nutrition and physiological stress, environmental shifts caused by climate change may foster exposure to new pathogens in Arctic marine mammals. Through altered animal behavior and absence of physical barriers, loss of sea ice may create new pathways for animal movement and introduction of infectious diseases into the Arctic. The health impacts of this new normal in the Arctic are unknown, but new open water routes through

[5] NOAA Arctic Program. Arctic Report Card: Update for 2018, Available at https://arctic.noaa.gov/Report-Card/Report-Card-2018/ArtMID/7878/ArticleID/789/Harmful-Algal-Blooms-in-the-Arctic, accessed November 2020.

the Arctic suggest that opportunities for Phocine distemper virus (PDV) and other pathogens to cross between North Atlantic and North Pacific marine mammal populations may become more common (VanWormer et al. 2019). PDV is a pathogen responsible for extensive mortality in European harbor seals (*Phoca vitulina vitulina*) in the North Atlantic. Prior to 2000, serologic surveys of Pacific harbor seals (*Phoca vitulina richardsii*), Steller sea lions, and northern sea otters off Alaska showed little evidence of exposure to distemper viruses, and PDV had not been identified as a cause of illness or death. PDV was not confirmed in the North Pacific Ocean until it was detected in northern sea otters sampled in 2004 (VanWormer et al. 2019). In addition to PDV, *Brucella*, and Phocid herpesvirus-1 have been found in Alaskan marine mammals (Zarnke et al. 2006). Herpesviruses were implicated in fatal and nonfatal infections of harbor seals in the North Pacific (Zarnke et al. 2006).

Ringed and bearded seals have co-evolved with numerous parasites and diseases, and these relationships are presumed to be stable. However, beginning in mid-July 2011, elevated numbers of sick or dead seals, primarily ringed seals, with skin lesions were discovered in the Arctic and Bering Strait regions. By December 2011, there were more than 100 cases of affected pinnipeds, including ringed seals, bearded seals, spotted seals, and walruses, in northern and western Alaska. Due to the unusual number of marine mammals discovered with similar symptoms across a wide geographic area, NMFS and USFWS declared a Northern Pinniped Unusual Mortality Event (UME) on December 20, 2011. Disease surveillance efforts in 2012 through 2014 detected few new cases similar to those observed in 2011. To date, no specific cause for the disease and deaths has been identified.

Likewise, in 2019, a UME was declared for bearded, ringed, and spotted seals in the Bering and Chukchi seas because of elevated mortality documented starting in June 2018 and continuing through the summer of 2019[6] (Table 7). The cause of the UME has not been determined but many of the seals had low fat thickness. All age classes were affected. The seals that were sampled did not have the hair loss or skin lesions that were prominent in the prior UME. Subsistence hunters noted that some of the seals had less fat than normal. The lowest sea ice maximums occurred in 2017 and 2018 when the retreat of sea ice was very rapid. It is unknown if these extreme sea ice conditions played a role in the health of the seals. As strandings and mortalities have returned to baseline levels, the UME will soon be closed. The NMFS does not know at this time why the ice seals are stranding, although HABs and/or disease are suspected (https://www.fisheries.noaa.gov/alaska/marine-life-distress/2018-2022-ice-seal-unusual-mortality-event-alaska, accessed March 2023).

[6] Barbara Mahoney, 2019, unpublished document. Ice Seal UME Update in the Alaska Region Marine Mammal Stranding Network Fall/Winter 2019 newsletter.

Table 7. Ice Seal Strandings[7]

Year	Bearded	Ringed	Spotted	Unidentified	Total
2018 (June 1-Dec 31)	35	29	20	27	111
2019	50	35	26	53	164
2020	10	9	8	11	38
2021	11	22	8	14	55
2022 (as of January 7))	0	0	0	0	0
Total	**106**	**95**	**62**	**105**	**368**

5.1.3 Vessel Traffic

Decreasing Arctic sea ice will: 1) facilitate an increase in vessel traffic associated with oil and gas exploration; 2) allow for increased tourism; and 3) open historically closed trade routes. The length of the navigation season in the Arctic has been growing by as much as 7-10 days annually, which, extrapolated over the next decade, could result in 2.5 months of additional navigation season over what was seen in 2019 (U.S. Committee on the Marine Transportation System 2019). The CMTS (U.S. Committee on the Marine Transportation System 2019) reported that the number of vessels operating in the Chukchi and Beaufort seas increased 128% from 2008 to 2018. The vessels included those used for research, natural resource exploration and extraction, commercial shipping, government/law enforcement/search and rescue, and tourism.

The Northern Sea Route shortens the transport distance between certain ports in northern Europe, northeast Asia, and northwest North America by up to 50% relative to routes through the Suez or Panama Canal. The Northwest Passage shortens the transit distance from western Europe to the Far East by 9,000 km in comparison to the conventional Panama Canal transit route (Khon et al. 2010). The two Arctic routes allow shipping companies to avoid increased tolls in the Suez and Panama Canals and provide routes for super ships that are larger and able to carry greater volumes of cargo (Nong et al. 2018). Of the 255 vessels that transited through the US Arctic and surrounding region from 2015-2017, over 50% were tug, towing, and cargo vessels. Thirty-two flag states transited the region, although US flagged vessels were the most prevalent (U.S.

[7] As of January 7, 2022; https://www.fisheries.noaa.gov/alaska/marine-life-distress/2018-2022-ice-seal-unusual-mortality-event-alaska, accessed March 2023

Committee on the Marine Transportation System 2019).

In an effort to predict the increase of vessel traffic through the Northwest Passage and the Northern Sea Route, Melia et al. (2016) used global climate models to project how sea ice loss might increase Arctic shipping. For a high-emission scenario, by late century, trans-Arctic shipping may be commonplace, with a season ranging from 4 to 8 months. For a low-emissions scenario, with global mean temperature stabilization of less than 2º C above preindustrial, the frequency of open water vessel transits still has the potential to double by midcentury with a season ranging from 2 to 4 months (Melia et al. 2016). As seasonal ice-free waters expand, the international commercial transport of goods and people in some Arctic areas is projected to increase 100-500 percent by 2025 (Adams and Silber 2017).

A greater number of vessels passing through the Arctic is expected to increase air-borne emissions levels (CO_2 and black carbon), underwater noise, trash, the potential for oil spills, risk of introduction of nonnative species, and the probability of ship strike.

5.2 Fisheries

Commercial, subsistence, and recreational fisheries within the action area may harm or kill listed marine species through direct bycatch, gear interactions (entrapments and entanglements), vessel strikes, contaminant spills, habitat modification, competition for prey, and behavioral disturbance or harassment.

Globally, 6.4 million tons of fishing gear is lost in the oceans every year (Wilcox et al. 2015). Entrapment and entanglement in fishing gear is a frequently documented source of human-caused mortality in cetaceans (see Dietrich et al. 2007). Fisheries interactions have an impact on many marine mammal species. More than 97 percent of whale entanglements are caused by derelict fishing gear (Baulch and Perry 2014). Materials entangled tightly around a body part may cut into tissues, enable infection, and severely compromise an individual's health (Derraik 2002a). Mortality from entanglement may be underreported, as many marine mammals that die from entanglement tend to sink rather than strand ashore.

Entanglement can include many different gear interaction scenarios, but the following have occurred with listed species covered in this opinion:

- Ingestion of gear and/or hooks can cause serious injury depending on whether the gear works its way into the gastrointestinal tract, whether the gear penetrates the gastrointestinal tract lining, is lodged in the esophagus, and the location of the hooking (e.g., embedded in the animal's stomach or other internal body parts) (Andersen et al. 2008, Helker et al. 2019).
- Gear loosely wrapped around the marine mammal's body that moves or shifts freely with the marine mammal's movement and does not indent the skin can result in disfigurement.
- Gear that encircles any body part and has sufficient tension to either indent the skin or to not shift with marine mammal's movement can cause lacerations, partial or complete fin

amputation, organ damage, or muscle damage and interfere with mobility, feeding, and breathing. Lines from weighed gear (e.g., crab pots) that becomes entangled with whales can cause drowning or exhaustion. In July 2010, a dead bowhead whale was found in Kotzebue Sound, entangled in crab pot gear similar to that used in the Bering Sea (Suydam et al. 2011a). In 2015, a dead female bowhead whale was found near St. Lawrence Island in the Bering Strait, entangled in fishing gear. The gear was identified as originating in the 2012/2013 winter commercial king crab fishery from the northern Bering Sea, near St. Matthew Island (Suydam et al. 2016, Muto et al. 2018).

- Chronic tissue damage from line under pressure can compromise a whale's physiology. Fecal samples from entangled whales had extremely high levels of cortisols (Rolland et al. 2005), an immune system hormone. Extended periods of pituitary release of cortisols can exhaust the immune system, making a whale susceptible to disease and infection.

(George et al. 2017) reported that 12 percent of harvested bowhead whales had scars consistent with entanglement. Larger bowheads were much more likely to be scarred. Nearly 50 percent of the harvested bowheads over 17 m had entanglement scars. In addition, at the time of the report, of the 15 incidents of bowhead whales actively entangled with man-made line, commercial fishing gear, or both, seven were found dead-stranded, and eight were observed alive and free-swimming (George et al. 2017).

From 2013 to 2017, the minimum estimated mean annual mortality and serious injury rate for bearded seals in U.S. commercial fisheries between 2014 and 2018 was 1.8 from two federally-managed US commercial fisheries in the Bering Sea and Aleutian Islands (Bering Sea/Aleutian Islands (BSAI) pollock trawl, BSAI flatfish trawl) (Muto et al. 2021). During the same timeframe, the minimum estimated mean annual mortality and serious injury rate for ringed seals by the U.S. commercial fisheries was 4.6 for BSAI flatfish trawl (Muto et al. 2021). Entanglement and entrapment in trawl fishery gear was the leading cause of serious injury and mortality for all phocids analyzed in Helker et al. (2019).

Because no commercial fisheries currently occurs in the Chukchi and Beaufort seas, any observed serious injury or mortality to listed species in the Arctic associated with commercial fisheries gear is currently attributable to interactions with fisheries in other areas, including in the BSAI management area.

Although no commercial fisheries currently occur in the Chukchi and Beaufort seas some fisheries may be expected to expand or shift northward in response to an increased length of the ice-free, open-water season in the future. Indeed, signals of change came to Norton Sound in 2021, when a new commercial fishery was attempted by Icicle Seafoods. Two floating processors and fish tenders were anchored around Nome to process pink salmon (https://www.arctictoday.com/in-alaskas-northern-bering-sea-a-commercial-pink-salmon-fishery-emerges/, accessed March 2023). Development of this novel commercial fishery in Norton Sound also brought the introduction of purse-seining, in which nets are encircled around an area and then drawn closed. Purse seines can easily encircle marine mammals along with the target species as the net is set (https://www.fisheries.noaa.gov/national/bycatch/fishing-gear-purse-seines#risks-to-marine-mammals, accessed March 2023), increasing the chance of bycatch.

5.3 Direct Mortality

Within the proposed action area there are several potential sources of direct mortality of listed species, including subsistence harvest, stranding, and predation. Mortality associated with vessels strikes is discussed in Section 4.1.2.

5.3.1 Subsistence Harvest

The ESA and MMPA allow for the harvest of marine mammals by Alaska Natives for subsistence purposes and for the creation of traditional handicrafts. Ringed seals are important subsistence species for many northern coastal communities. Approximately 64 Alaska Native communities in western and northern Alaska, from Bristol Bay to the Beaufort Sea, regularly harvest ringed and bearded seals for subsistence purposes (Nelson et al. 2019). Estimates of subsistence harvest of ringed seals are available for several of these communities based on annual household surveys, but more than 50 other communities that harvest these species for subsistence were not surveyed within this time period or have never been surveyed. From 2012-2017, only 4 percent (3 of 64) of the coastal communities that harvest ice seals have been surveyed in two or more consecutive years (Ice Seal Committee 2019). Household surveys are designed to estimate harvest for the specific community surveyed; extrapolation of harvest estimates beyond a specific community is not appropriate because of local differences in seal availability, cultural hunting practices, and environmental conditions (Ice Seal Committee 2019). In 2015, the total annual ringed seal harvest estimate across surveyed communities was 6,454 (Table 8). Nelson et al. (2019) determined this level of harvest is sustainable.

Table 8. Average regional and statewide subsistence harvest (including struck and lost animals) of Arctic ringed seals in 2015 (summarized from Nelson et al. (2019)).

Region	Average harvest (including struck and lost)
North Slope Borough	1,146
Maniilaq	493
Kawerak	2,287
Association of Village Council Presidents	2,484
Bristol Bay Native Association	44
Statewide total	6,454

Subsistence hunters removed 209 Western DPS Steller sea lions between 2014 and 2018 in controlled and authorized harvests (Muto et al. 2021). Steller sea lions have historically been utilized as a food resource, for construction materials, and cultural artifacts.

Whaling by Alaska Natives in the Alaskan Arctic and sub-arctic has taken place for at least 2,000 years (Marquette and Bockstoce 1980, Stoker and Krupnik 1993). Subsistence harvest for bowhead whales has been regulated by quotas set by the International Whaling Commission (IWC) and allocated to the Alaska Eskimo Whaling Commission since 1977. Alaska Native subsistence hunters from 11 Alaska villages take approximately 0.1 to 0.5 percent of the population per annum (Philo et al. 1993, Suydam et al. 2011). Under this quota, the number of kills in any one year has ranged between 14 and 72. The maximum number of strikes per year is set by a quota which is determined by subsistence needs and bowhead whale abundance and trend estimates (Stoker and Krupnik 1993). Suydam and George (2012) summarized Alaska subsistence harvests of bowhead whales from 1974 to 2011 by village and reported that a total of 1,149 whales were landed by hunters from 11 villages, with Barrow landing the most whales (n = 590) and Shaktoolik landing only one. The number of whales landed at each village varies greatly from year to year, as success is influenced by village size and ice and weather conditions (Table 9). The efficiency of the hunt (the percent of whales struck that are retrieved) has increased since the implementation of the bowhead whale quota in 1978. In 1978, the efficiency was about 50 percent. In 2016, 47 of 59 whales struck were landed, resulting in an efficiency of 80 percent, which was slightly higher than the previous 10-year average of 75 percent (Suydam et al. 2017).

Table 9. Annual number of bowhead whales landed by Alaska natives

Year	Number of Landed Whales
2010	45
2011	38
2012	55
2013	46
2014	38
2015	38
2016	47
2017	43
2018	47
2019	Information not available
2020	Information not available
2021	57

Year	Number of Landed Whales
2022	53

Sources: (Suydam et al. 2011b, Suydam et al. 2012, Suydam et al. 2013, Suydam et al. 2014, Suydam et al. 2015, Suydam et al. 2016, 2017, AEWC unpublished data, 2017) and https://archive.iwc.int/pages/search.php?search=%21collection73&k=

Canadian and Russian Natives also take whales from this stock. Hunters from the western Canadian Arctic community of Aklavik harvested one whale in 1991 and one in 1996. No catches for Western Arctic bowhead whales were reported by either Canadian or Russian hunters for 2006 and 2007 (IWC 2008, 2009) or by Russia in 2009, 2011, 2012, 2014, 2021, or 2022 (IWC 2011, Ilyashenko 2013, Ilyashenko and Zharijov 2015, IWC 2021, IWC 2022), but two bowhead whales were taken in Russia in 2008 (IWC 2010), two in 2010 (IWC 2012), and one in 2013 (Ilyashenko and Zharijov 2014).

Annual subsistence take by Natives of Alaska, Russia, and Canada from 2010 through 2014 averaged 44 bowhead whales. During the 2013 through 2018 time period, the IWC and Alaska Eskimo Whaling Commission (AEWC) are allowing Alaskan and Chukotkan whalers to land up to 336 bowhead whales total (AEWC 2018).

5.3.2 Stranding

As discussed in Section 5.1.2 the NMFS Alaska Region Stranding Network received reports of many stranded ice seals in spring and summer 2019. In September, NMFS declared an Unusual Mortality Event (UME) for ringed, bearded, and spotted seals, dating back to June 1, 2018. The cause, or causes, of these deaths is currently being investigated by NMFS.

5.3.3 Predation

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

Polar bear predation on ringed seal pups tripled when pups were prematurely exposed as a consequence of unseasonably warm conditions. Hammill and Smith (1991) further noted that polar bear predation on ringed seal pups increased four-fold when average snow depths in their study area decreased from 23 cm to 10 cm. Avian predation is facilitated not only by lack of sufficient snow cover but also by conditions favoring influxes of birds (Kelly et al. 2010b).

Steller sea lions are a component of transient killer whales' diet. In 1992, 14 Steller sea lion flipper tags were found in the stomach of a killer whale (Heise et al. 2003). Remote video and vessel based surveys at the Chiswell Island rookery documented 9 killer whale predation events observed from the vessel and 16 inferred events from the video recordings (Maniscalco et al. 2007). The authors estimate that 59 Steller sea lions were consumed by killer whales over the summer seasons of 2002-2005. Loughlin and York (2000) estimated that 300 Steller sea lions were eaten by killer whales each year across the Gulf of Alaska and the Aleutian Islands.

Transient killer whales overlap spatially and temporally with bowhead whales and are year-round inhabitants of the Bering Sea (Dahlheim and White 2010). Thirty-three bowhead whale carcasses were documented in July–October, from 2009 to 2018 during ASAMM surveys (Willoughby et al. 2020). Carcasses were distributed across the eastern Chukchi and western Beaufort seas. Eighteen bowhead whale carcasses having injuries consistent with probable killer whale: four each in 2016 and 2018, three each in 2013 and 2015, two in 2012, and one each in 2010 and 2017 (Willoughby et al. 2020). Using passive acoustic monitors Stafford (2018) found that the number of days transient killer whales were acoustically detected increased from September to November over a seven-year series from 2009 to 2015, and increased from June through November from 2013 to 2015. George et al. (2017) also found an increasing prevalence of injuries or scars from killer whale predation attempts in landed bowhead whales, with a higher probability of killer whale rake mark scars on bowheads from 2002 to 2012 compared to the prior two decades (1990–2011). Increased killer whale predation on bowhead whales in the eastern Chukchi and western Beaufort seas may be associated with the dramatic sea ice reduction during summer and autumn that may allow killer whales to hunt in areas that were previously ice covered, similar to conditions occurring in the eastern Canadian Arctic (Higdon and Ferguson 2009, Reinhart et al. 2013).

5.4 Pollutants and Contaminants

5.4.1 Marine debris

In late July 2020, the Bering Strait region of Alaska experienced a marine debris event that brought garbage ashore and caused concern about coastal communities' food security, marine wildlife health, human health and conservation. Through mid-November, individuals from 14 communities discovered and documented over 350 individual items ashore, most with Russian, Korean, and/or other Asian lettering or branding. During this event, about 25 miles of coastline in the vicinity of Nome was littered with trash and debris (Sheffield et al. 2021). As maritime ship traffic increases through the Bering Strait region, similar or higher levels of marine garbage may be encountered leading to higher levels of marine mammal entanglement or the ingestion of harmful, non-nutritious items.

5.4.2 Plastics

A growing source of contaminants in the Arctic comes from plastics. Approximately 8,300 million metric tons (MT) of plastics have been produced to date with approximately 6,300 million MT becoming waste (Geyer et al. 2017). Jambeck et al. (2015), in an analysis of plastic waste generated by 20 coastal communities world-wide, estimated that 4.8 to 12.7 million MT of plastic waste entered the ocean in 2010. It is estimated that between 62,000 to 105,000 tons of plastic are transported to the Arctic Ocean each year (Zarfl and Matthies 2010). Larger sized plastics such as bottle caps, plastic bags, bottles, and strapping are problems for marine sea birds, turtles, and mammals because of ingestion and entanglement (Laist 1997, Derraik 2002b, Law 2017, Peeken et al. 2018). We have no documented reports of strandings of ringed or bearded seals caused by entanglement or plastic ingestion from the action area. However, entanglement of Northern fur seals (*Callorbinus ursinus*) from around the Pribilof Islands is well documented (Laist 1997, Savage 2019). With increased development in the Beaufort and Chukchi Seas, increased vessel traffic through the Northwest passage, an increased number of observers (tourists, scientists, employees), and longer periods of open water which can promote delivery of plastics to the Arctic, ingestion and entanglement of ringed and bearded seals is more likely to be documented in coming years.

Microplastics, defined as < 5 mm in size, occur due to the release of manufactured plastic particles in various products (primary microplastics) and the fragmentation of larger plastic pieces (secondary microplastics) (Cole et al. 2011). Microplastics are distributed globally. In an examination of ice cores from widely dispersed locations across the Arctic Ocean, Obbard et al. (2014) found from 38 to 234 particles per cubic meter of ice. The microplastic concentrations were several orders of magnitude greater than those reported in the North Pacific Subtropical Gyre (0.12 particles per cubic meter of water). The highest concentration of microplastics ever determined in sea ice was found in from the Makarov Basin in the central Arctic Ocean (Peeken et al. 2018). The ice core there contained concentrations comparable to those from South Korean waters, which were previously highest levels recorded (Peeken et al. 2018). The types of microplastics found in the Arctic included polystyrene, acrylic, polyethylene, polypropylene, nylon, polyester, and rayon (Obbard et al. 2014, Peeken et al. 2018). Microplastics are also abundant in Arctic benthic substrates (Lusher et al. 2015, Bergmann et al. 2017) and water (La Daana et al. 2018, La Daana et al. 2020).

Marine plastic debris is associated with a 'cocktail of chemicals', including chemicals added or produced during manufacturing (Lithner et al. 2011, Rochman 2015) and those present in the marine environment that accumulate onto the debris from surrounding seawater (Mato et al. 2001, Hirai et al. 2011). Persistent organic pollutants, including PCBs, and metals have been well documented as sorbing onto plastic particles in studies dating back to 1972 (Mato et al. 2001, Ogata et al. 2009, Zarfl and Matthies 2010). Microplastics and the persistent bioaccumulative toxins they carry have been documented in filter feeders including zooplankton, mussels, planktivorus fish and humpback whales (Besseling et al. 2014, Besseling et al. 2015, Fang et al. 2021) and benthic invertebrates from the shelf of the Bering and Chukchi Seas ((Fang et al. 2018). There is evidence that the sorbed contaminants are bioavailable to a variety of marine mammals and invertebrates (Teuten et al. 2009, Rochman 2015). Researchers are actively investigating whether these plastic-associated contaminants biomagnify in higher trophic levels as a direct result of plastic ingestion and how important bioaccumulation from plastic is relative to bioaccumulation from other sources of chemical contamination in the environment (Avio et al. 2015, Rochman 2015, Miller et al. 2020).

5.4.3 Heavy metals

There is particular concern about mercury in Arctic marine mammal food webs (Macdonald et al. 2003). Mercury concentrations in marine waters of the Arctic are higher than concentrations in temperate and tropical waters due in large part to deposition of metallic and inorganic mercury from long-range transport and atmospheric deposition events that occur at higher latitudes (Outridge et al. 2008). Mercury levels in Arctic marine predators, such as belugas, ringed seals and polar bears, have increased ten-fold over the past century ((Dietz et al. 2006, Outridge et al. 2008), and in some populations, are above multiple thresholds for neurological effects (Dietz et al. 2013). Mercury concentrations were elevated in Steller sea lion pups in the western and central Aleutian Islands (Castellini et al. 2012; Rea et al. 2013; Rea and O'Hara 2018). Rea et al. (2013) found fetal exposure to mercury in sea lions, during late gestation, which is a particularly vulnerable stage of neurological development.

Heavy metals can enter marine mammals through uptake from the atmosphere through the lungs, absorption through the skin, across the placenta before birth, via milk during lactation, ingestion of sea water and ingestion of food (Vos et al. 2003). The major route of heavy metal contamination for marine mammals seems to be via feeding. Additionally, because mercury biomagnifies, being a top predator in the food web can influence heavy metal levels, especially in marine mammals relying on fish (Vos et al. 2003).

Bratton et al. (1993) looked at eight metals (arsenic, cadmium, copper, iron, mercury, lead, selenium, and zinc) in the kidneys, liver, muscle, blubber, and visceral fat from bowhead whales harvested from 1983 to 1990. They observed considerable variation in tissue metal concentration among the whales tested. Metal concentrations evaluated did not appear to increase over time. The metal levels observed in all tissues of the bowhead are similar to levels reported in the literature in other baleen whales. Tissues collected from bowhead whales landed at Barrow in 1992, indicated that they had very low levels of mercury but they had elevated concentrations of cadmium in their liver and kidneys (Becker et al. 1995).

Heavy metals such as mercury, cadmium, lead, selenium, arsenic, and nickel accumulate in ringed and bearded seals’ vital organs, including liver and kidneys, as well as in the central nervous system (Kelly et al. 2010b). Gaden et al. (2009) suggested that during ice-free periods the seals eat more fish that bioaccumulate mercury. Smith and Armstrong (1978) reported that rates of accumulation appear to be somewhat higher in bearded seals as compared to ringed seals. Becker et al. (1995) reported ringed seals in Norton Sound had higher levels of arsenic in than ringed seals taken by residents of Point Hope, Point Lay, and Barrow. Arsenic levels in ringed seals from Norton Sound were quite high for marine mammals, which might reflect localized natural sources of arsenic, an element that often co-occurs with gold.

5.4.4 Pollutants

Persistent organic pollutants (POPs; e.g. DDT, PCBs) in Arctic marine mammals have been documented since the late 1960s (Aguilar et al. 2002). These chemicals have a long lifetime in the environment, are transported over long distances, enter food-webs, and often biomagnify in wildlife and humans (Burkow and Kallenborn 2000, Rigét et al. 2019). Although far from the pollution sources, the Arctic is a receptor of POPs transported from temperate regions via air and water currents (Mossner and Ballschmiter 1997, Burkow and Kallenborn 2000). Research on contaminants in ringed and bearded seals and bowhead whales is extensive throughout the Arctic environment because these species are an important part of the diet for coastal human communities (Cameron et al. 2010, Kelly et al. 2010b, Bolton et al. 2020). Major classes of POPs show declining trends in Arctic animals since reaching a peak in the early 1980s with reductions of about 2 to 10 percent per year ((Bolton et al. 2020). These reductions are in response to the banning or regulation of the use of POPs such as DDT, PCBs, and polybrominated diphenyl ethers (flame retardants) greatly reducing inputs into the environment (Rigét et al. 2019, Bolton et al. 2020). In addition to transport of POPs from outside the region, fuel spills into marine waters are another source of contaminants. Although small fuel spills have been documented in Nome, no large spills have impacted the community.

Mossner and Ballschmiter (1997) reported that total levels of polychlorinated biphenyls and chlorinated pesticides in bowhead blubber from the North Pacific and Arctic Oceans were many times lower than those in beluga whales or northern fur seals. However, while total levels were low, the combined level of isomers of chlorinated pesticides was higher in the blubber tested from bowhead whales than from three marine mammal species sampled in the North Atlantic (pilot whale, common dolphin, and harbor seal). These results were believed to be due to the lower trophic level of the bowhead as compared to the other marine mammals tested. Pollutants such as organochlorines have been found in all of the subspecies of ringed seal with the exception of the Okhotsk ringed seal. The variety, sources, and transport mechanisms of contaminants vary across ringed seal ecosystems (Kelly et al. 2010b).

Lee et al. (1996) compared persistent organochlorine pesticides and PCBs in Steller sea lions in the Gulf of Alaska to Steller sea lions in the Russian waters of the Bering Sea. PCBs were the predominant organochlorine in Steller sea lion blubber, followed by DDT. The level of PCBs in male Steller sea lions were higher than those in ringed seals in Arctic waters. Steller sea lions in the Bering Sea had significantly lower DDTs and PCBs than those from the Gulf of Alaska (Lee et al. 1996). Ferdinando (2019) assessed heavy metals in marine mammals including Steller sea lions. In the southwest Alaska area consisting of the Aleutian Islands, mercury was the heavy metal of highest concentration in Steller sea lions, followed by lead, nickel, and copper. Ferdinando (2019) found arsenic levels were either very low or not detected in vibrissae of Steller sea lions. Holmes et al. (2008) tested tissues from 27 Steller sea lion pups (19 from Eastern DPS, 8 from Western DPS) for heavy metals. Mercury was the element of greatest concern as it occurred in nearly all the tissues sampled. Arsenic was detected in approximately half of the samples. The authors note that toxicological studies are needed to assess the toxicity of various metals.

5.5 Scientific Research

Research assists in the recovery of threatened and endangered species; however, research activities can also disturb these animals. Research on marine mammals often requires boats, adding incrementally to the vessel traffic, noise, and pollution in the action area. NMFS issues scientific research permits that are valid for five years for ESA-listed species. When permits expire, researchers often apply for a new permit to continue their research. Additionally, applications for new permits are issued on an on-going basis; therefore, the number of active research permits is subject to change in the period during which this opinion is valid.

Species considered in this Opinion also occur outside U.S. waters. Although we do not have specific information about research activities in waters outside of the U.S., we assume they are similar to those described below.

Cetaceans

Bowhead whales are exposed to research activities documenting their biology, behavior, habitat use, stock structure, social organization, communication, distribution, and movements throughout their ranges. Activities associated with these permits occur in the action area, in some cases at the same time as the proposed project activities.

Currently permitted research activities include:

- Counting/surveying, aerial and vessel-based
- Opportunistic collection of sloughed skin and remains
- Behavioral and monitoring observations
- Various types of photography and videography
- Skin and blubber biopsy sampling
- Fecal sampling
- Suction-cup, dart/barb, satellite, and dorsal fin/ridge tagging
- Acoustic, active playback/broadcast, and passive recording
- Acoustic sonar for prey mapping

Some of these research activities require close vessel approach. The permits also include incidental harassment takes to cover such activities as tagging, where the research vessel may come within 100 yards of other whales while in pursuit of a target whale. These activities may cause stress to individual whales and cause behavioral responses. In some cases, take could occur and is authorized

Pinnipeds

Steller sea lions, ringed seals, and bearded seals are exposed to research activities documenting their population status and trends, health, movements, habitat use, foraging ecology, response to recovery activities, distribution, and movements throughout their ranges.

There are several active scientific research permits for marine mammals in Alaska. Their activities may include behavioral observations, counting/surveying, photo-identification, and capture and restraint (e.g. by hand, net, or trap). The following samples may be collected from marine mammals: blood, hair, urine and feces, nasal and oral swabs, whiskers, skin, blubber, or muscle biopsies, and weight and body measurements. Drugs are administered if necessary (e.g. intramuscular, subcutaneous, or topical) for pain, restraint, or to prevent infection, instruments are attached to hair or flippers, and ultrasound may be used to measure blubber thickness.

These activities may cause stress to individual pinnipeds and cause behavioral responses. Two ringed seals have died as a consequence of research activities over the last 10 years from research that was permitted in the United States. Protocols are modified when a mortality occurs. NMFS processes and reviews any applications for scientific research permits, and take is authorized if appropriate. Although we do not have specific information about research activities for pinnipeds in waters outside of the United States, we assume they are similar to those described above.

5.6 Prior Section 7 Consultations

A formal section 7 consultation was conducted with NMFS Sustainable Fisheries division for the BSAI groundfish fishery. In the Bering Sea, state commercial fisheries include herring and salmon. Direct interactions between commercial hook and line and trawl fisheries with ringed and bearded seals results from being captured on hooks nets and drowning. Indirect effects may occur through habitat alteration from the contact of trawl gear on the sea floor, altering and removing prey species for ringed and bearded seals. The result may be lowered body condition leading to reduced survival. In October, 2010 NMFS issued a final rule requiring the modification of non-pelagic trawl gear in the directed flatfish fishery in the Bering Sea subarea to raise portions of the gear off the ocean bottom (75 FR 61642). NMFS took this action to reduce potential adverse effects of nonpelagic trawl gear on bottom habitat. From 2016 through 2020, six bearded seals and 28 ringed seals were killed in commercial fisheries gear (Freed et al. 2022).

In 2017, NMFS issued an ITS for a subsea cable laying action, occurring between Nome and Olitok Point on the North Slope. This action spanned more than 1,900 km (1,180 m) in the Bering, Chukchi and Beaufort seas. Authorized Level B take (i.e., behavioral harassment) across the entire action area was 62 bearded seals, 855 ringed seals, and 8 Steller sea lions. Total sightings of ESA-listed species in the action area during project monitoring included 14 bearded seals, 77 ringed seals, and 2 Steller sea lions.

Since 2019, several informal section 7 consultations have occurred in or near the Port of Nome project area (Table 10). The most common stressor among these consultations was acoustic disturbance.

Table 10. Informal section 7 consultations in the Port of Nome action area, in which NMFS determined the proposed action was not likely to adversely affect listed species or critical habitat:

Title	Year	Species/critical habitat	Potential Impacts
IPOP Bonanza Channel/Safety Sound year-round Coring	2021	Arctic ringed seal; Beringia bearded seal;	Acoustic/physical disturbance; Habitat alteration; Contamination; Entanglement
Nome Inner Harbor Dredging	2021	Arctic ringed seal; Beringia bearded seal; Western DPS SSL; Ringed seal critical habitat; Bearded seal critical habitat	Acoustic disturbance; Vessel strike; Modification of critical habitat
Nome Harbor Dredging	2020	Arctic ringed seal; Beringia bearded seal; Western DPS SSL	Acoustic disturbance; Vessel strike; Habitat alteration; Contamination
IPOP Bonanza Channel/Safety Sound Winter Coring	2020	Arctic ringed seal; Beringia bearded seal;	Acoustic/physical disturbance; Habitat alteration;
Nome Inner Harbor Small Boat Ramp	2019	Arctic ringed seal; Beringia bearded seal;	Acoustic/physical disturbance; Physical harm; Prey impacts; Habitat alteration

5.7 Summary of Environmental Baseline

The Arctic ecosystem is currently undergoing many changes at an unprecedented rate. The most important changes are related to global warming and include diminishment in the extent and thickness of sea ice, increasing surface water temperatures, shrinkage of the cold water pool, increased harmful algal blooms, increased vessel traffic, and increased levels of plastics. Other activities like subsistence harvest and predation have been ongoing for decades and are expected to continue. Counting bearded and ringed seals is extremely difficult and for that reason it has not been possible to determine an accurate count for either species. Consequently, absolute abundance of these species is unknown, however, estimates for each species are still well above 100,000. Bowhead populations are stable or increasing. Ringed seals, bearded seals, and bowhead whales appear to be resilient to the environmental perturbations they have faced thus far. The Western DPS Steller sea lion population is still low and increasing slowly. However, because the majority of the population is concentrated around the Aleutian Islands, they are less affected by environmental factors near Norton Sound.

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 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* and *Environmental Baseline* sections of this opinion with the results of our exposure and response analyses to estimate the probable risks the proposed action poses to endangered and threatened species.

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

During our assessment, we identified six stressors associated with the proposed action. Based on the proposed activities the following stressors have been identified:

1. in-water sound fields produced by non-impulsive sound sources from vibratory pile driving and from impulsive sound sources from impact pile driving;
2. seafloor disturbance from pile driving, dredging, filling, and placement of equipment or anchors;
3. contamination of marine habitat;
4. risk of collisions associated with vessel traffic both in the project area and along the vessel transit route;

5. non-impulsive in-water sound fields produced by vessel transit, dredging, and fill; and
6. physical harm from construction activities.

Of these stressors, the in-water sound created by pile driving of sheet piles and pipe piles is a major stressor and will be discussed in Section 6.1.2. Stressors 2-6 are minor stressors.

6.1.1 Minor Stressors on ESA-Listed Species and Critical Habitat

The effects of the following minor stressors are expected to be too small to detect or measure and are not likely to significantly disrupt the normal behavioral patterns of ringed seals, bearded seals, Steller sea lions, or bowhead whales. Minor effects to the animals are discussed first followed by effects to their critical habitat. The discussion of effects to critical habitat from minor stressors is included in this section for streamlining purposes, but note that the action is not likely to adversely affect critical habitat. The analysis focuses on effects to critical habitat designated for ringed seals and bearded seals because the nearest Steller sea lion critical habitat is approximately 200 km to the southwest on Saint Lawrence Island and critical habitat has not been designated for bowhead whales.

6.1.1.1 Seafloor Disturbance

Turbidity

During pile installation and removal, dredging, and filling, a temporary and localized increase in turbidity and sedimentation near the seafloor will occur in the immediate area surrounding each disturbance. In general, turbidity associated with pile installation is expected to be localized to about a 25-foot radius around the pile (Everitt et al. 1980). Turbidity and sedimentation rates are naturally high in this region due to ice scouring and gouging of the seafloor, significant delivery of suspended sediments from river outflows, and coastal erosion. Consequently, the additional suspension of sediment from pile driving and dredging over a limited amount of time and area is not anticipated to have a measureable impact on water quality, prey important to listed marine mammals, nor to marine mammals themselves. Ringed and bearded seals, Steller sea lions, and bowhead whales are not expected to come close enough to the project activities to encounter increased turbidity. If they did encounter a localized plume of more turbid water it is highly unlikely that it would cause a measurable disruption of behavioral patterns or cause any physiological response as turbid water created by storms and from stream runoff is likely a regular occurrence in their habitat. Because bowhead whales are irregular visitors to Norton Sound we do not expect that any aspect of seafloor disturbance would have an effect on individual whales.

In summary, the impact of habitat alteration is expected to be minor due to the relatively small area of impact. Turbidity created by project activities is not expected to exceed levels that ringed and bearded seals and Steller sea lions experience naturally as a consequence of storms and currents. Because the turbidity will be localized, individuals would be able to easily swim to areas not affected by turbidity. We conclude that the effects of turbidity on ringed and bearded seals, Steller sea lions, and bowhead whales will be immeasurably small.

Contaminants

The proposed action may disturb sediments that have elevated concentrations of arsenic. Suspended solids in water from dredging, pile driving, and pile extraction have the potential to distribute the contaminant. Notably high concentrations (up to 200 milligrams/kg [mg/kg]) of metallic element arsenic were regularly detected in sediment samples from the Inner Harbor area and from Snake River (USACE 2012). In contrast, Crecelius et al. (1990) found that the Snake River, which enters Norton Sound at Nome, did not appear to be a significant source of metals. Seawater samples collected in the turbidity plume of the BIMA gold dredge contained elevated concentrations of total metals as a result of suspended sediment. However, dissolved metals were not significantly elevated in seawater down-current of the gold dredge (Crecelius et al. 1990).

Sources of arsenic are from soil erosion, volcanic eruptions, and gold mining as gold deposits are often associated with arsenic. The State of Alaska has not established marine sediment threshold levels but threshold effects levels from Washington State and NOAA range from 57 mg/kg to 7 mg/kg, respectively (USACE 2012).

Arsenic has been detected consistently in sediments at the pre-identified, near-shore placement site and along the adjacent beach. A geotechnical investigation showed that arsenic in the seabed sediments is concentrated in a layer of glacial till, usually overlain by a surficial layer of unconsolidated marine sands that contain much lower arsenic concentrations (USACE 2022).

As discussed in Section 4.2.1.3, one consequence of climate change is ocean acidification. Zhang et al. (2022) found that acidification could cause more dissolved inorganic arsenic to be transported into the overlying water from sediments or suspended particulates which would be favorable to arsenite, the more toxic form. Because dredging maintenance is expected to occur regularly at the Port of Nome, arsenic could be re-suspended on a regular basis. Total arsenic in the liver of ringed seals from Norton Sound has been reported to be, on average, two to three times higher than the average levels found in the liver of this and other species of pinnipeds and cetaceans from other Alaska locations and elsewhere (Becker et al. 1997). The arsenic in marine biota is generally in an organic form, mostly arsenobetaine, and at this time appears to be nontoxic and of little concern to humans using them as food (Luvonga et al. 2020). Crecelius et al. (1990) found that the concentrations of arsenic in hair samples from 200 Nome women were below the levels of concern for human health.

Juvenile ringed and bearded seals are known to gather at the Outer Harbor during salmon in-migrations, and Steller sea lions may visit the Port of Nome/Snake River vicinity in late summer to feed on salmon. However, salmon that are returning to streams to spawn stop feeding so it is very unlikely that the salmon would ingest prey with elevated levels of arsenic. Consequently, salmon are an unlikely source of dietary arsenic for the pinnipeds.

The USACE will perform arsenic bioaccumulation tests on arsenic-rich sediment from the project dredging prism in 2023. Depending upon final chemical and physical characterization of the dredging prism, dredged materials will be loaded to either a scow or truck for delivery to any of several predesignated and approved sites. Those predesignated sites include a nearshore placement area, an upland location, the current beach nourishment site, or offshore disposal location.

In summary, high levels of arsenic have been documented in the sediments in and around Nome. Dredging will likely create turbidity plumes that have higher concentrations of arsenic. To have a measurable effect on a listed marine mammal, their prey would need to ingest and accumulate arsenic and then be consumed by the listed marine mammal. Because all of the listed marine mammals we consider in this opinion are migratory, moving north and south or inshore/offshore in relationship to ice levels, individual animals would potentially only consume prey items from Nome harbor for a short amount of time in any given year, limiting the amount of arsenic-exposed prey they might consume. Ringed seal density is very low in the area and we only expect bearded seal juveniles in the area. Once bearded seals mature they do not choose to be near shore or people. Consequently, their consumption of prey from the harbor would be limited. Although arsenic levels in livers of ringed seals from Norton Sound were found to be high, we have no information indicating that these levels have led to health issues. For these reasons, we do not expect that dredging or pile driving in the Nome harbor is going to lead to a measurable reduction of health or fitness in ringed or bearded seals. Steller sea lions and bowhead whales are infrequent visitors to the project area and we would expect any elevation in arsenic levels from project activities would have no effect on them because of extremely limited exposure.

Petroleum or other contaminants may accidentally spill into the project area from machinery, construction-associated vessels, or dredging activities. Discharges of petroleum hydrocarbons are expected to be small and are not expected to result in high concentrations of contamination within the surface waters. During construction, mitigation measures will be implemented to minimize the risk of fuel spills and other potential sources of contamination, and the USACE will require SPCC Plans for both land and vessel operations. The expanded Port may indirectly create the potential for larger marine spills due to the larger ships' ability to enter the Port. However, the USACE expects larger but fewer vessels will enter the Port, minimizing the need for offshore fuel transfers (USACE pers. comm. 2023), which may reduce the chances of marine spills. Thus, we conclude that if any fuel spills, it will be a small quantity and is likely to dissipate and evaporate quickly.

Bowhead whales would not overlap with construction activities in the harbor and the density of bearded and ringed seals, and Steller sea lions in the harbor are low, lessening the probability of overlap with any small spills from vessels or equipment. We therefore expect the impacts of fuel spills on bearded and ringed seals, Steller sea lions, and bowhead whales is immeasurably small.

6.1.1.2 Effects of seafloor disturbance on critical habitat

Turbidity

Critical habitat has not been designated for bowhead whales and the nearest Steller sea lion critical habitat is approximately 200 km to the southwest on Saint Lawrence Island. Critical habitat for Steller sea lions will not be affected by project activities. We focus our discussion on effects to ringed and bearded seal critical habitat. Two of the PBFs for the seals focus on characteristics of sea ice, the third focuses on prey. Sea ice will not be affected in any way by sea floor disturbance. For bearded seals waters 200 m or less in depth containing benthic organisms, including epifaunal and infaunal invertebrates, and demersal fishes are essential prey and for ringed seals small, often schooling, fishes, in particular Arctic cod, saffron cod, and rainbow smelt (*Osmerus mordax*), as well as small crustaceans, in particular, shrimps and amphipods are essential prey.

Because the project is occurring at a site that is already disturbed and frequently used by vessels it is highly unlikely that direct disturbance to the sea floor within the harbor will cause any measurable loss of prey. Disposal of dredged materials at an ocean site may impact prey species by crushing, dislodging, or smothering (i.e., clogging of the gills or other feeding structures) with the deposited spoils. However, many invertebrates are able to survive burial by burrowing up through the spoils (Powilleit et al. 2009). In addition, although an area of productive habitat could be temporarily lost by spoils deposition, the area would be insignificant in comparison to the total area of sea floor. Over time (two to four years) areas where invertebrates were killed or depleted would be recolonized (Harvey et al. 1998, Bolam and Rees 2003, Fredette and French 2004) reaching former levels of productivity. The size of the area that will be affected by dredging for the new causeway construction and for the harbor itself is very small in relationship to Norton Sound and the total amount of critical habitat available. Any loss of food resources that may occur in the project area would be exceedingly small in comparison to those that would still be available. Any physical changes or loss of habitat would not likely reduce the foraging quality of surrounding waters (e.g., the localized availability of fish) for bearded and ringed seals.

Contaminants

Clean fill will be used in the construction of the OCSP dock and reconstructed causeway. Fill material will be obtained from local sources (Cape Nome Quarry), thus it will be free of non-native marine and terrestrial vegetation species.

As discussed above, dredged material may disperse arsenic. Remobilizing contaminants in sediments by dredging may impact ringed and bearded seal critical habitat by adversely affecting prey quality (PBF #3). However, Jewett and Naidu (2000) found that arsenic levels in red king crabs (*Paralithodes camtschaticus*) were not significantly different between Norton Sound and other areas sampled in the North Pacific, suggesting that although elevated elemental arsenic is found in sediments within the action area, it may not have a significant effect on prey species.

Effects to benthic prey or schooling fishes as a result of remobilizing contaminates, especially while dredging, will likely be immeasurable.

The total area of designated critical habitat for Arctic ringed seal is approximately 149 million acres. The total area of designated critical habitat for Beringia DPS bearded seal is approximately 164.5 million acres. The total area of the sea floor that may be impacted by new rock placement, dredging, and dredged material deposition is less than 500 acres and is an extremely small percent of the total available. Given that the area of impact is small in size in relationship to designated critical habitat, arsenic levels in potential prey are not elevated, and health consequences to seals and humans have not been documented, we conclude that effects of arsenic resuspension due to the proposed action are immeasurable.

Short-term effects on prey species may occur if petroleum or other contaminants accidentally spill into the project area from machinery, construction-associated vessels, filling, or dredging activities. Discharges of petroleum hydrocarbons are expected to be small and are not expected to result in high concentrations of contamination within the surface waters. During construction, mitigation measures will be implemented to minimize the risk of fuel spills and other potential sources of contamination, and the USACE will require SPCC Plans for both land and vessel operations. The expanded Port may indirectly create the potential for larger marine spills due to the larger ships' ability to enter the Port. However, the USACE expects larger but fewer vessels will enter the Port, minimizing the need for offshore fuel transfers (USACE pers. comm), which may reduce the chances of marine spills. Thus, we conclude that if any fuel spills, it will be a small quantity and is likely to evaporate quickly. We therefore expect the impacts of fuel spills on bearded and ringed seal critical habitat as a result of this proposed action to be immeasurably small.

6.1.1.3 Vessel Transit

Vessel transit for this project will occur in the open water season. Although bowhead whales have been struck by vessels (George et al. 2017) because of the remoteness of their habitat, it is difficult to know how many bowhead whales may be struck and killed in a year. George et al. (2017) found scars associated with ship strike on approximately 2 percent of harvested bowhead whales. Because we expect all, or nearly all, bowhead whales to be north of the Bering Strait when project-specific vessels are traveling between Anchorage and Nome, we expect little or no exposure of bowheads to the effects of vessels, either vessel strike or vessel noise.

Steller sea lions will have greatest probability of exposure near the Aleutian Islands where they are more abundant and juvenile ringed and bearded seals will most likely overlap with vessels near the Port of Nome.

Bearded and ringed seals will be able to hear vessels from a distance and if disturbed, would likely move away. Although Sternfeld (2004) documented a single spotted seal stranding in Bristol Bay, Alaska that may have resulted from a propeller strike, no incidents of ship strike for bearded or ringed seals are noted in the Stock Assessment Reports (Muto et al. 2021) or in recent reports of human caused mortality and serious injury of listed marine mammals in Alaska

(Delean et al. 2020). Seals are extremely agile and capable of moving quickly in the water, greatly reducing the probability of being struck by a vessel.

Western DPS Steller sea lions are most likely to be encountered near Unimak Pass and the Aleutian Islands. From 2000 to 2022 there have been three confirmed reports of vessel strike involving Steller sea lions; two near Sitka (2007, 2009) and one in Tracy Arm of Southeast Alaska in 2018. Like seals, Steller sea lions are extremely agile in the water, greatly reducing the probability that they will be struck by a vessel. The extremely rare occurrence of ringed seal, bearded seal and Steller sea lion vessel strikes combined with the mitigation measures regarding vessel operation around marine mammals indicates that vessel strike is highly improbable.

Although the USACE does not expect this project to significantly increase marine vessel traffic utilizing the Port of Nome (USACE 2020), with the availability of a deep water port and increasing vessel traffic as a consequence of a longer open water season, some level of increased vessel use is expected. However, the low density of pinnipeds in open water, their agility and ability to detect an approaching vessel, and adherence to the mitigation measures, including maintaining a vigilant watch for marine mammals during all vessel operations and speed restrictions, leads us to conclude a vessel strike of a pinniped during construction or in the future is highly unlikely.

6.1.1.4 Effects of Vessel Transit on Critical Habitat

The essential features of Beringia DPS bearded and Arctic ringed seal critical habitat focus on the presence and characteristics of sea ice and prey resources. Vessel transit for both the Anchorage-Nome and the Port of Nome-Cape Nome travel routes will be across open water. There will be no effect to sea ice from the vessel transit. The passage of the ship on the surface of the water and the potential for vessel-related pollutants impacting the fish and benthic organisms that are prey for bearded and ringed seals is improbable, and thus, we conclude this activity will not result in any measureable effect on bearded and ringed seal critical habitat.

6.1.1.5 Effects of Sound Produced by Dredging and Fill

Port of Nome is the regional port for Norton Sound, where vessel activity is concentrated during the open water season. Ambient sound level (e.g., tidal currents, sea ice melting, wind, and waves breaking) and background sounds, caused by anthropogenic activities such as transiting vessels, has not been measured in the project area. We expect, however, that sound sources from general construction activities, such as placing gravel and dredging will temporarily increase the ambient in-water sound. We do not expect that a bowhead whale would enter the harbor area where exposure to construction sounds could occur, therefore we expect no exposure to the in-water sound effects from construction noise such as placing fill or dredging to bowheads.

Dredging during the Port of Nome Modification project will occur during both Phase 1 and Phase 2, although the equipment to be used has not been determined. Sound created by dredging operations is dependent on factors such as dredge type, substrate type, bathymetry, geomorphology of the waterway, site-specific hydrodynamic conditions, equipment maintenance status, and skill of the dredge operator (McQueen et al. 2019). Clam shell dredges or backhoe dredges are the equipment used most often in Alaska, however, there is a possibility suction dredges may be used (Chris Floyd, USACE pers. comm, 3/20/2023). Dredge-induced underwater sounds are typically continuous and non-impulsive and broadband, with most energy below 1 kHz (Robinson et al. 2011, Reine et al. 2012, 2014, Reine and Dickerson 2014) it is unlikely to cause damage to the auditory systems of marine mammals (Todd et al. 2014, McQueen et al. 2019, Suedel et al. 2019).

Decibel levels recorded from various dredging types range from approximately 100 to 190 dB re 1μPa at 1m (Suedel et al. 2019). The loudest sound associated with clamshell dredging occurs when the bucket hits the substrate (Dickerson et al. 2001). Non-impulsive sound of 149 dB re 1 μPa at 1m occurs during bucket winching. With a transmission loss coefficient of 15 this yields a Level B threshold (to the 120 dB isopleth) of 86 m. Suction dredges can be louder than clamshell dredges but the soft depositional materials within the harbor would create less sound than if coarser, larger, angular gravel or rock were being dredged. We expect the 300 m shutdown zone will avoid adverse effects for a suction dredge and a clamshell dredge. Beyond 300 m, noise produced by dredging is not reasonably expected to result in a significant disruption to ringed seal, bearded seal, or Steller sea lion behavior patterns such as breeding, feeding, or sheltering and effects to the animals would not be measureable.

6.1.1.6 Effects of Sound Produced by Dredging and Fill on Critical Habitat

The prey PBF for ringed and bearded seals is the only aspect of critical habitat that may be impacted from this stressor. Acoustic impacts to invertebrates are still poorly known and currently it is almost impossible to come to clear conclusions on the nature and levels of man-made sound that have potential to cause effects upon these animals (Hawkins et al. 2015, Solé et al. 2023). However because dredging and filling activities will create low level and continuous sound, and occur over a relatively small area and short period of time we do not expect that they would have a meaningful or measureable effect on invertebrate prey of pinnipeds. Likewise, fish are much more susceptible to injury from impulsive sound than to continuous sound (Popper et al. 2014, Popper and Hawkins 2019). Consequently, we would not expect any direct injury to fish that might be in the harbor from the sound created by dredging or fill. However, they would likely move away from the area, unless the dredging made more prey items available. We expect the sounds created by dredging to have an immeasurably small effect on the prey of bearded and ringed seals and, consequently, the effects to their critical habitat will also be immeasurably small.

6.1.1.7 Physical Harm from Construction Activities

During all in-water or over-water construction activities having the potential to directly harm marine mammals, a shutdown zone of 10 meters (m) will be enforced to ensure that animals are not endangered by physical interaction with construction equipment. These activities could include, but are not limited to support-vessel activities, barge operations, the positioning of piles via a crane ("stabbing" the pile), the removal of piles via a crane ("deadpull"), the over-water slinging of construction materials and the placement of fill. We expect that the easily observable shutdown zone will prevent physical harm to all marine mammals in the area.

6.1.2 Major Stressors on ESA-Listed Species and Critical Habitat

In-water sound created by pile driving of sheet piles and pipe piles is the only major stressor from the proposed action and is discussed below. We provide a brief explanation of the sound measurements and acoustic thresholds used in the discussions of acoustic effects in this opinion and then we assess the likelihood that a bearded seal, ringed seal, Steller sea lion, or bowhead whale will be exposed to the sound. Lastly, we assess the effects of the exposure to individuals of those species and to their populations.

6.1.2.1 Acoustic Thresholds

Since 1997, NMFS has used generic sound exposure thresholds to determine whether an activity produces underwater and in-air sounds that might result in impacts to marine mammals (70 FR 1871, 1872; January 11, 2005). NMFS has developed comprehensive guidance on sound levels likely to cause injury to marine mammals through onset of permanent and temporary thresholds shifts (PTS and TTS) (83 FR 28824; June 21, 2018; 81 FR 51693; August 4, 2016). NMFS is in the process of developing guidance for behavioral disruption (Level B harassment). However, until such guidance is available, NMFS uses the following conservative thresholds of underwater sound pressure levels,[8] expressed in root mean square[9] (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

Under the PTS/TTS Technical Guidance, NMFS uses the following thresholds (Table 12) for underwater sounds that cause injury, referred to as Level A harassment under section 3(18)(A)(i) of the MMPA (16 U.S.C § 1362(18)(A)(i)) (NMFS 2018). Different thresholds and auditory weighting functions are provided for different marine mammal hearing groups, which are

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

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

defined in the Technical Guidance (NMFS 2018). The generalized hearing range for each hearing group is in Table 11.

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

Hearing Group	ESA-listed Marine Mammals In the Project Area	Generalized Hearing Range[1]
Low-frequency (LF) cetaceans *(Baleen whales)*	Bowhead whales	7 Hz to 35 kHz
Mid-frequency (MF) cetaceans *(dolphins, toothed whales, beaked whales)*	None	150 Hz to 160 kHz
High-frequency (HF) cetaceans *(true porpoises)*	None	275 Hz to 160 kHz
Phocid pinnipeds (PW) *(true seals)*	Ringed and bearded seals	50 Hz to 86 kHz
Otariid pinnipeds (OW) *(sea lions and fur seals)*	Steller sea lions	60 Hz to 39 kHz

[1]Respresents the generalized hearing range for the entire group as a composite (i.e., all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on ~65 db threshold from normalized composite audiogram, with the exception for lower limits for LF cetaceans (Southall et al. 2007) and PW pinniped (approximation).

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[10] associated with NMFS Acoustic Guidance, or through modeling.

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

Table 12. PTS Onset Acoustic Thresholds for Level A Harassment (NMFS 2018).

Hearing Group	PTS Onset Acoustic Thresholds[1] (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

[1] 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 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) (except that take is not prohibited for threatened species that do not have ESA section 4(d) regulations).

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, PTS can occur. When PTS occurs, auditory sensitivity is unrecoverable (i.e., permanent hearing loss). The effect of sound 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 Exposure Analysis

As discussed in the *Approach to the Assessment* section of this opinion, exposure analyses are designed to identify the listed species that are likely to co-occur with these effects in space and time and the nature of that co-occurrence. In this step of our analysis, we try to identify the number, age (or life stage), and 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.

6.2.1 Exposure Assumptions

- Because pile driving and pile removal produce similar sound profiles and levels (MacGillivray et al. 2015), vibratory pile driving sound estimates will be used as a proxy for vibratory pile removal sound levels.
- Exposures are based on total number of days that pile driving could occur and that animals might occur in the ensonified area.
- One day equates to any length of time that piles are driven whether it is a partial day or a 24-hour period.
- All listed marine mammals occurring in the Level A or Level B ensonified zones are assumed to be incidentally taken.

- Marine mammal exposure within the Level B isopleth, but outside the maximum observable distance in which a PSO can reliably identify pinnipeds on the water's surface (2,000 m), are assumed proportional to the number of marine mammals actually observed during the same activity, and at the same time and day.
- An individual animal can only be counted as taken once during a 24-hour period.
- For animals that may occur in groups, each individual in the group would be considered taken.
- A practical spreading value of 15 is a conservative but appropriate value for the transmission loss coefficient for calculating the ensonified zone in the absence of site-specific information.

As discussed in Section 2.1.2 above, the USACE proposed mitigation measures designed to avoid or minimize exposure of Arctic ringed seal, Beringia DPS bearded seal, Western DPS Steller sea lion, and bowhead whales to the stressors from the proposed action. These mitigation measures require the use of PSOs to call for a shutdown of pile driving when a listed marine mammals appears about to enter or enters a predetermined area of water (shutdown zone) in which sound levels may cause harm to the animal. However, as described below, we anticipate that exposures to listed marine mammals from noise associated with the proposed action may result in behavioral disturbance. No mortalities or permanent impairment to hearing are expected and none are authorized.

6.2.2 Distances to Level A and Level B Sound Thresholds

Port of Nome modification activities include vibratory sheet and pipe pile driving and vibratory pipe pile removal. Impact pile driving is proposed as well, but will only be used if a sheet pile cannot be driven to the desired depth using the vibratory pile driver. Sound source levels for the piles were adopted from the California Department of Transportation (CalTrans 2015) (Table 14). For this action, pile extraction using a vibratory hammer is considered to have equivalent sound source levels to installation of piles of the same size and material using a vibratory hammer (MacGillivray et al. 2015). Pile driving will occur intermittently during the open water season (approximately June through October) over three seasons for Phase 1.

NMFS developed a User Spreadsheet that can be used to predict an isopleth distance for use in conjunction with marine mammal density or occurrence to help predict potential takes. Because of some of the assumptions included in the methods underlying this tool, the isopleth estimates are typically overestimates of potential take by Level A harassment. However, the tool offers the best way to estimate isopleth distances when more sophisticated modeling methods are not available or practical. For stationary sources such as pile driving, the User Spreadsheet tool predicts the distance at which, if a marine mammal remained at that distance for the duration of the activity, it would be expected to incur PTS. Inputs used in the User Spreadsheet tool, and the resulting estimated isopleths for level A and B take are shown in Table 13. The isopleth distances are calculated based on the sound pressure levels expected for the various pile driving activities (Table 14).

As can be seen in Table 13, the Level A isopleths for the pinnipeds is small; 26 m radius is the largest for a ringed or bearded seal underwater. However, this small area can be easily observed by PSOs or construction workers ensuring that pile driving would stop so that the animals are not harmed. The Level A zone is bigger for low frequency baleen whales (bowhead whale, 43 m) but it would be very obvious if a bowhead whale was inside the harbor during the open water season. Level A take is not authorized for any species.

Table 13. Distance in meters for Level A and Level B harassment isopleths. Impact pile driving will be used infrequently or not at all. LF (low frequency cetaceans = bowhead whales), PW (ringed and bearded seals underwater), and OW (Steller sea lions underwater) are the marine mammals we consider in this opinion.

Pile type	Level A harassment isopleths (m)					Level B harassment isopleth (m)
	LF	MF	HF	PW	OW	
VIBRATORY						
Temporary template piles (Pipe piles ≤24″)	5	<1	7	3	<1	1,848
(Alternate) Temporary template piles (H-piles 14″)	3	<1	4	2	<1	1,000
Anchor piles (14″ HP14x89 or similar)	3	<1	4	2	<1	1,000
Sheet piles (20″ PS31 or similar)	18	2	27	11	<1	5,168
Fender piles (Pipe piles 36″)	43	4	64	26	2	21,544
IMPACT						
Temporary template piles (Pipe piles ≤24″)	252	9	300	135	10	858
(Alternate) Temporary template piles (H-piles 14″)	40	1	48	21	2	159
Anchor piles (14″ HP14x89 or similar)	40	1	48	21	2	159
Sheet piles (20″ PS31 or similar)	231	8	276	124	9	858
Fender piles (Pipe piles 36″)	386	14	459	206	15	1,585

As can be seen in Table 13, installation of sheet piles is expected to create a large ensonified area (radius of 5,168 m from source) (Figure 21). Because so many sheet piles will be installed (1,600 per season), it will take approximately 57 days each season in Phase 1 for the sheet pile installation. Comparatively, new dock construction in Kotzebue in 2020 also used interlocking pairs of sheet piles (PND 2021b), as will be done in Nome. We expect the two locations have a similar substrate (soft sandy to gravelly mud) given their protected location at the mouths of large streams (USACE 2012). In Kotzebue, driving similar interlocking pairs of sheet piles required only one to two minutes each to install (PND 2021b). More time will be spent moving and positioning the sheet piles and the pile driver than is needed to actually drive the piles.

A sound source verification (SSV) was conducted during the Kotzebue project with measurements taken at approximately 10, 100, 500, and 1,000 m from the pile driving (PND 2021a). Average SPL at 10 m for the 10 sheet pile pairs measured was 158.2 dB RMS re 1 μPa. The 1,000 – 2,000 Hz frequency band dominated the sound near the source. At greater distances, lower frequencies were dominant. The vibratory hammer noise at 1,000 m from the construction site was difficult to detect above the noise produced by current and hydrophone motion in the water (PND 2021a). For the Nome proposed project, a slightly higher sound source level of 160.7 dB RMS re 1 μPa was used to calculate the zone that would be ensonified to 120 dB (Table 14). If we had used the SSV value of 158.2 dB RMS re 1 μPa measured for the similar project in Kotzebue, the area ensonified would be approximately 3,521 m radius, about 1,650 m smaller than what was calculated for this project. However, we analyzed the effects resulting from a slightly higher sound source level (160.7 dB) to get a more conservative estimate because this is a larger project than the Kotzebue project, while noting that it is likely the sound from the sheet pile installation will reach 120 dB closer to 3,500 m than 5,168 m. The USACE plans on conducting an SSV at the beginning of their operations at Nome. After their results are reviewed, and if approved, the Level B zones may be modified to reflect local conditions.

Table 14. Vibratory and impact installation and removal SPL values by pile size[11] used to calculate the radius of the ensonified zone.

Source	**Predicted Vibratory driving Source Level (SPL rms)**	**Predicted Impact[12] driving Source Level (SPL rms)**
Temporary template 24” pipe piles (Installation)	154.0	189.0
Temporary template 24” pipe piles (Removal)	154.0	N/A
Temporary template 14” H-piles (Installation)	*150.0*	*178.0*
Temporary template 14” H-piles (Removal)	*150.0*	*N/A*
Anchor H piles 14”	150.0	178.0
Sheet piles 20”	160.7	189.0
Fender piles 36”	170.0	193.0

The sequence of construction has important implications for the amount of area we expect to be ensonified. The sheet piles will not be driven into open water where the sound can travel in all directions. The rock causeway will be built first and the sheet piles will trail behind, only on the harbor side of the rock causeway (see Figure 2 for finished product). Although the rock causeway will not be completed before the sheet pile installation begins, causeway construction

[11] Temporary template, 14” H-piles are potential “alternate” pile types to the 24” pipe piles, and are italicized.
[12] Impact pile driving is a secondary method used only when vibratory installation cannot drive pile to desired depth.

will always precede the sheet pile installation because the installation process needs protection from the ocean waves, swell, and currents. For this reason, we expect sound from sheet pile and pipe pile installation and removal will travel to the east (Figure 21 and Figures 1-5, Appendix 1) as sound propagation westward will be blocked by the causeway. However, we do expect some sound may "leak" around the leading edge of the causeway so we have added a 10 degree deflection to west past the edge of the causeway. Once the causeway is completed, the noise from all sheet piles and pipe piles that are installed on the short arm of the 'L' will be directed towards shore and the inner harbor and the area ensonified will be much smaller and easier for the PSOs to monitor.

Vibratory installation of fender (pipe) piles will create the largest ensonified area amongst this project's component pile driving activities (radius of 21,544 m from source) (Table 13). Consequently, pinnipeds and the bowhead whale would have the greatest chance of exposure to harmful levels of sound during installation of the fender piles. The duration of this disturbance will be compressed into a small proportion of the overall construction season because the installation of the 21 piles per year can reportedly be accomplished in just a few days per year (USACE 2023). We expect that the last fender piles to be installed will be on the short arm of the 'L'. Because this part of the project will occur at the end of phase 1, after the majority of the causeway has been constructed, we expect noise from the pile driving in the third year will directed towards the shore; consequently, a much smaller area will be ensonified compared to the prior two years in which the sound can travel unimpeded to the east. Although a much smaller area will be ensonified in the third year of construction compared to the first two years, we have conservatively analyzed all three years as having the same ensonified zone.

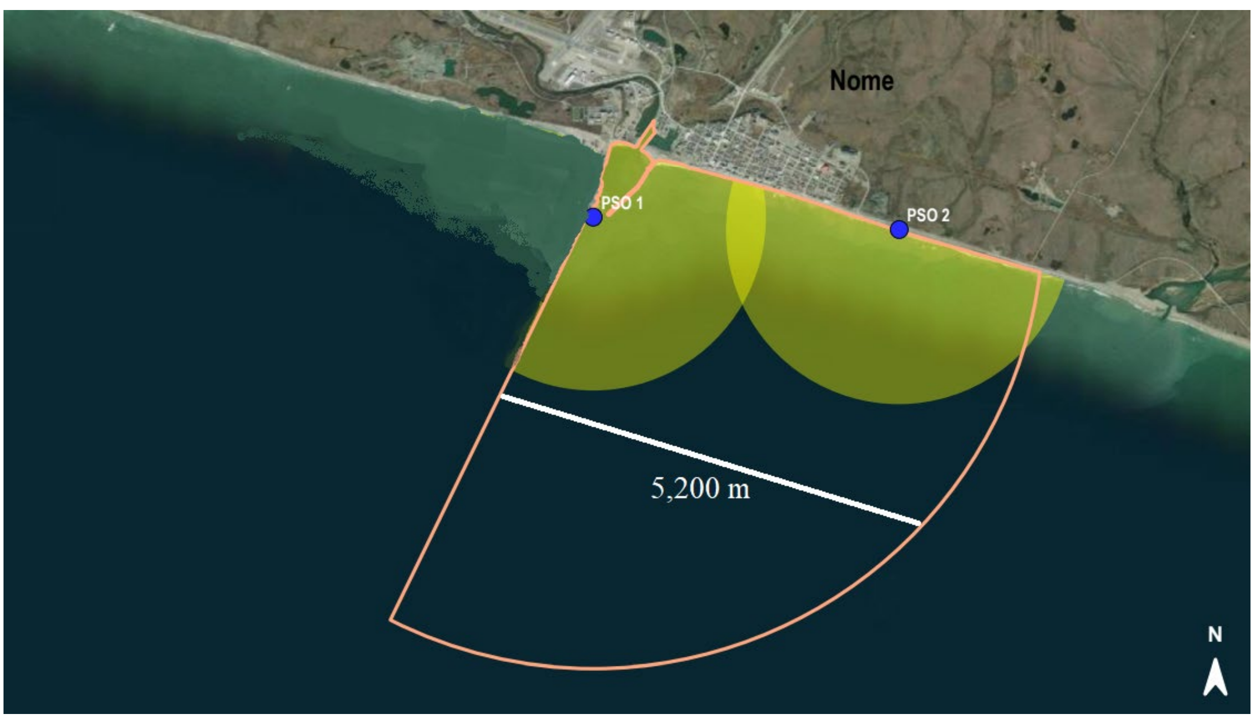

Figure 21. Level B harassment zone for 20" sheet piles is outlined in orange (zone has a radius of 5,200 m). The yellow shaded area is the area that a protected species observer (PSO) can reliably observe marine mammals. Zone location is not fixed; it would change as the causeway is built out.

6.2.3 Estimating Exposure to Major Noise Sources

For this analysis we estimated take by considering: 1) acoustic thresholds above which the best available science indicates marine mammals will be behaviorally harassed or incur some degree of temporary or 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 (0.39 bearded seals/km^2, 0.02 ringed seals/ $km^{2)}$ and 4) the number of days of activities. Because Steller sea lions and bowhead whales are uncommon to rare visitors to the waters near this proposed port, a density estimate was not used to calculate their exposure. Based on the number of animals that are typically seen, the density would be extremely low leading to an estimate that no exposure would occur. Instead, we assumed that one Steller sea lion per day could appear at the project area throughout the construction season (85 days) and that a total of two bowhead whales could occur in the action area over the entire project (i.e., a single individual, as has been observed on occasion in the past, and the addition of one bowhead, representing a cow's calf).

NMFS considered the mitigation measures (that are part of the proposed action), which include shutdown zones encompassing ensonified areas that may result in Level A take (Table 15). Implementing shutdown zones significantly reduces the possibility of exposure to sound that could cause injury. No Level A take is expected to occur because of the small easily observable area around the pile driving operation and no Level A take is authorized. As mentioned above, for bearded and ringed seals we estimate the number of exposures based on the density of animals multiplied by the area that will be ensonified. Take for bearded seal, ringed seal, Steller sea lions, and bowhead whales is presented in Table 15.

Table 15. Number of bearded seals, ringed seals and Steller sea lions expected within the Level B isopleth during each open water season of Phase 1 and the total for all three Phases. BS=bearded seals, RS = ringed seals, SSL= Steller sea lions.

Source	Days of effort/each open water season[13]	Level B ensonified area (km^2)[14]	Number of BS[15]	Number of RS[16]	Number of SSL[17]	BS	RS	SSL
			Each Open Water Season[18]			Total over 3 seasons of phase 1		
Temporary template piles (24") installation[19]	12	4.7	22	1	12	66	3	36
Temporary template piles (24") removal	12	4.7	22	1	12	66	3	36
Anchor piles (H- 14")	2	1.7	1	0	2	3	0	6
Sheet piles (20")	57	28.1	625	32	57	1875	96	171

13 Days of effort each of 3 open water seasons are constant throughout Phase 1

14 Level-B total area minus Level-A total area; total areas calculated using isopleth radius for each Level type

15 Beringia DPS bearded seal density = 0.39

16 Arctic ringed seal density = 0.02

17 Assumes 1 Steller sea lion in the area per day.

18 Three open water seasons are expected for pile driving. Assumes density or rate remain constant across time.

19 Only 24" temporary template pile are display as the alternate template pile is 14" and emits a lesser acoustic value

Fender pile (36”)	2	416	325	17	2	975	51	6
Total For Each Open Water Season	85	NA	995	51	85	2,985	153	255

Because adult bearded seals are rarely found near shore and are very wary of people, we expect that any bearded seals that are in the area will likely be juveniles. Likewise, the majority of adult ringed seals are farther north in the open water season or are associated with ice. Therefore, we expect that it will likely be juvenile ringed seals that might be exposed to sound. Because Nome is so far from a Steller sea lion rookery where pups and juveniles would be more common, we expect that adult Steller sea lions will be in the project area. We have no age class information on bowheads in Norton Sound and assume a bowhead of any age could be exposed to sound.

6.2.4 Exposure Analysis to Critical Habitat

The discussion of effects to critical habitat from the major stressor of in-water sound is included in this section for streamlining purposes, but note that the action is not likely to adversely affect critical habitat for ringed seals, bearded seals, and Steller sea lions. No critical habitat has been designated for bowhead whales. Critical habitat has been designated for Western DPS Steller sea lions but the nearest critical habitat is over 200 km away from Nome; it will not be affected by any of the proposed project activities.

The proposed project will occur in designated critical habitat for ringed and bearded seals. As described in sections 4.3.2 and 4.3.4, two of the three PBFs for ringed and bearded seals involve the presence and characteristics of sea ice. As the proposed project will occur during the open water season, we do not expect any direct effects to sea ice. In addition, we do not expect any indirect effects to sea ice as a consequence of the project.

As discussed in section 6.1.1, none of the minor stressors are expected to affect critical habitat for ringed and bearded seals. We examine here if the noise produced by sheet pile and pipe pile driving will affect their critical habitat. The third PBF for both ringed and bearded seals involves prey. For ringed seals, prey is defined as small, often schooling, fishes, in particular Arctic cod, saffron cod, and rainbow smelt, as well as small crustaceans, in particular, shrimps and amphipods. For bearded seals, prey includes benthic organisms (i.e., epifaunal and infaunal invertebrates), and demersal fishes in water 200 m or less in depth.

Because of the expansion of the existing causeway and construction of the new breakwater to the east of the existing one, a small amount of soft, muddy habitat currently available to benthic invertebrates will be permanently lost by the proposed port modifications. However, the addition of the irregular hard substrate (rock causeway, fender piles) will increase habitat diversity and provide cover for immature crabs and juvenile fish. No adverse impacts on benthic populations are expected due in part to their large reproductive capacities. Any mortalities or impacts that might occur because of the planned activities are negligible compared to the naturally occurring high reproductive and mortality rates.

Although impact pile driving can cause fish injuries or mortalities (Popper and Hastings 2009), it has not been documented for vibratory pile driving (Nedwell et al. 2003, Burgess et al. 2005b). Prolonged (more than one hour), close (<10m) exposure could potentially affect the hearing of fish (Burgess et al. 2005), however, it is highly unlikely that this kind of exposure would occur in a natural setting where fish are free to swim away For these reasons we conclude that vibratory pile driving would not have an effect on fish that might be prey for ringed or bearded seals. Acoustic impacts to invertebrates are still poorly known; it is currently almost impossible to come to clear conclusions regarding the effects that man-made sound may have upon these animals (Hawkins et al. 2015, Solé et al. 2023). Although there may be a behavioral response of invertebrates to vibratory pile driving (e.g. clams temporarily closing up), given the intermittent and short time interval that the pile driving will last, we do not expect that this would cause mortality to invertebrates. In conclusion, we expect that the quantity and quality of the prey resources that comprise features essential to ringed and bearded seal critical habitat will be immeasurably affected and will not have a measureable effect on the overall prey available to ringed and bearded seals.

6.3 Response Analysis

As discussed in the *Approach to the Assessment* section of this opinion, response analyses determine how listed species / critical habitats are likely to respond after being exposed to an action's effects on the environment or directly on listed species themselves. Our assessments try to detect the probability of lethal responses, physical damage, physiological responses (particular stress responses), behavioral responses, and social responses that might result in reducing the fitness of listed individuals. For critical habitat, our assessments try to identify which of the action's effects will impact or alter the physical and biological features of critical habitat and the magnitude of the impacts or alterations relative to the value of critical habitat as a whole for the conservation of a listed species. Ideally, our response analyses consider and weigh evidence of adverse consequences, beneficial consequences, or the absence of such consequences.

The response of a marine mammal to an anthropogenic sound depends 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 if it is perceived as approaching or moving away can affect the way an animal responds to a sound (Wartzok et al. 2003).

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:

- Non-auditory physiological effects
- Disturbance reactions; changing from one behavioral state to another, and/or
- Avoidance or movement out of the ensonified area
- Masking

6.3.1 Non-auditory physiological response

6.3.1.1 Pinnipeds

Stress is the primary non-auditory physiological effects that could occur in marine mammals exposed to underwater sound from the project. Marine, like terrestrial, mammals may exhibit a generalized stress response (elevated levels of "stress hormones" such as cortisol and corticosterone) to anthropogenic noise in their environment (Rosen and Kumagai 2008). Prolonged exposure to stress may result in immune system suppression, reproductive failure, accelerated aging, and slowed growth.

Although most research on physiological stress response has focused on terrestrial species (Wright et al. 2007, Atkinson et al. 2015), stress responses of marine mammals have been reviewed (ONR 2009) and studied (Fair et al. 2017; Romano et al. 2005). Clark et al. (2005) documented adrenal exhaustion in chronically stressed marine mammals. Rolland et al. (2012) found that noise reduction from lower exposure to ship traffic in the Bay of Fundy was associated with decreased stress in North Atlantic right whales. These and other studies lead to a reasonable expectation that some marine mammals, including pinnipeds, could experience physiological stress responses upon exposure to intense and repeated sounds.

For non-impulsive sounds, data suggest that exposures of pinnipeds to sources between 90 and 140 dB re 1 µPa do not elicit strong behavioral responses (Kvadsheim et al. 2010). Although hood seals (*Cystophora cristata*) initially responded to sounds by reducing diving activity, increasing rapid exploratory swimming at surface, and lifting their heads out of the water, upon repeated exposure, regardless of signal frequency, the seals adapted to the exposure. The initial exploratory surface swimming ceased and they directly transitioned from diving to passive floating with their heads out of the water in an area furthest from the sound source. The seals had the option of hauling out on a platform, but none did. Their heart rate increased at the surface indicating emotional activation during sound exposure, but lack of effect of exposure on heart rate during diving indicates that physiological responses during diving remained normal (Kvadsheim et al. 2010).

Experimentally, Götz and Janik (2011) tested underwater responses in wild-captured gray seals to a startling sound (sound with a rapid rise time and a 93 dB sensation level) and a non-startling sound (sound with the same level, but with a slower rise time). The animals exposed to the startling treatment avoided a known food source, whereas animals exposed to the non-startling treatment either did not react or habituated during the exposure period. The results of this study highlight the importance of the characteristics of the acoustic signal in an animal's habituation. In cases where marine mammal response is brief (i.e., changing from one behavior to another, relocating a short distance, or ceasing vocalization), the effect(s) are not likely to be measurable at the population level, but could rise to the level of take of individuals.

Individual pinnipeds could react to the continuous sounds created by the vibratory pile driving at Nome harbor by alerting or temporarily avoiding the area close to the source; however, feeding or reproduction is unlikely to be compromised because the behavioral response is expected to be very short in duration. The expected response of swimming away from the sound source or raising the head above the water surface is not likely to increase energy expenditure to the point of significantly disrupting normal behavioral patterns. Based on the reactions of hooded seals (Kvadsheim et al. 2010) and gray seals (Götz and Janik 2010) we expect that seals that stay within the Level B zone would habituate to the sound and would have very little reaction after the initial start up of pile driving. In cases where marine mammal response is brief (i.e., changing from one behavior to another, relocating a short distance, or ceasing vocalization), the effect(s) are not likely to be measurable at the population level, but could rise to the level of take of individuals. The production of noise producing activities, related to the Port of Nome modification project will occur throughout the open water season for 3 years. However, the loudest noise (from pile driving) will be episodic. Sheet pile pairs in Kotzebue took fewer than 5 minutes to install. More time is spent moving equipment and positioning the piles than actually driving them. The loudest noise produced, from the installation of the fender piles, is expected to last approximately two days each open water season. Noise from dredging, rock placement, vessels, and pile driving is expected to increase the ambient and background sound level and intermittently add large amounts of sound to the underwater habitat. These noise levels could cause stress to individuals that are sensitive to sound and they may avoid the harbor and other ensonified areas, especially when pile driving is occurring.

6.3.1.2 Bowhead whales

Norton Sound has not been identified as an important migration corridor or Biologically Important Area for bowhead whales (Moore and Laidre 2006, Ferguson et al. 2015, Citta et al. 2020). Based on tagging surveys and traditional ecological knowledge, most bowheads will be north of the Bering Strait by the time Norton Sound is ice free and project activities begin. For these reasons we expect little co-occurrence of bowheads and project activities. However, we have been informed that bowheads occasionally appear in Norton Sound near Nome (Austin Ahmasuk pers. comm. 2023). If a bowhead did appear in Norton Sound during the open water season construction period, we expect that it would be migrating north to summer feeding grounds. Migrating bowheads have been documented as being very sensitive to airgun sounds in the Beaufort Sea (Richardson 1999) with deflection from the noise occurring as far as 35 km away. Although the noise produced by the vibratory pile driving will not be impulsive and will not be as loud as that produced by the seismic airguns, we expect that if a migrating bowhead encountered the noise produced by vibratory pile driving it would deflect around it, likely resulting in an increase in its migration energy expenditure.

6.3.2 Disturbance Reactions

6.3.2.1 Pinnipeds

Behavioral responses of marine mammals to noise can include subtle or more conspicuous changes in activities, and displacement. Marine mammal behavioral responses to sound are highly variable and context-specific, and reactions, if any, depend on species, state of maturity, experience, current activity, reproductive state, auditory sensitivity, time of day, and many other factors (Southall et al. 2007, Götz and Janik 2011, Ellison et al. 2012). Possible disturbance can range from mild (e.g., startle response) to severe (e.g., abandonment of vital habitat). Behavioral responses are influenced by an animal’s assessment of whether a potential stressor poses a threat or risk. Behavioral responses may include: changing durations of surfacing and dives, changing direction and/or speed, changing/cessation of certain behavioral activities (such as socializing or feeding), visible startle response or aggressive behavior, avoidance of areas where sound sources are located, and/or, flight responses. Differential responses are expected among and within species based on age, prior experience, activity at time of exposure (e.g. feeding vs resting), individual characteristics (e.g. more or less sensitive), and hearing acuity. Therefore, individuals of the same species may react differently to the same, or similar, stressors.

Individuals exposed to noise can experience stress and distress. Distress is a stress response resulting in a biological consequence to the individual. Both stress and distress can affect survival and productivity (Curry and Edwards 1998, Cowan and Curry 2002, Herráez et al. 2007, Cowan and Curry 2008), and metabolic physiology (Kight and Swaddle 2011). Mammalian stress levels can vary by age, sex, season, and health status (St. Aubin et al. 1996, Gardiner and Hall 1997, Hunt et al. 2006, Romero et al. 2008), and may be influenced by an animal’s exposure to repeated disturbance (i.e., habituation), individual tolerances, or other factors (Ellison et al. 2012).

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

For non-impulsive sounds, data suggest that exposures of pinnipeds to sources between 90 and 140 dB re 1 µPa do not elicit strong behavioral responses (Kvadsheim et al. 2010). Although hooded seals (*Cystophora cristata*) initially responded to sounds by reducing diving activity, increasing rapid exploratory swimming at surface, and lifting their heads out of the water, upon repeated exposure, regardless of signal frequency, the seals adapted to the exposure. The initial exploratory surface swimming ceased and they transitioned from diving to passive floating with their heads out of the water in an area furthest from the sound source. The seals had the option of hauling out on a platform, but none did. Their heart rate increased at the surface, indicating emotional activation during sound exposure, but lack of effect of exposure on heart rate during diving indicates that physiological responses during diving remained normal (Kvadsheim et al. 2010).

Monitoring conducted before, during and after a similar dock modification project in Kotzebue found the primary behavior of all seals (includes spotted seals) observed during pre and post-construction was to 'look', and the secondary behavior was to 'mill' about. The majority of seals had no reaction to construction activity (PND 2021). Most of the seals identified were spotted seals, followed by ringed seals. No bearded seals were recorded but they may have occurred in the 'unidentified' category. Ringed seals showed some degree of tolerance to impact pile driving at Northstar Island in the Beaufort Sea, which was attributed to apparent low sensitivity to disturbance, habituation, and inquisitive behavior of immature animals (Richardson 2008).

Marine mammal monitoring for the Kodiak Ferry Dock project (ABR 2016) documented 1,281 Steller sea lions within the Level B harassment zone during pile driving or drilling, but of these, only 45 individuals (3.5 percent) demonstrated any evidence of behavioral disturbance. Nineteen showed alert behavior, 7 were documented fleeing, and 19 swam away from the project site. Other sea lions were engaged in activities such as milling, feeding, playing or fighting and did not change their behavior. In addition, two sea lions approached within 20 meters of active vibratory pile driving activities (ABR 2016). These results indicate that at least some pinnipeds outwardly show little reaction to noise and construction activities.

We expect pile driving associated with the proposed action will result in individual Beringia DPS bearded seals, Arctic ringed seals, and Western DPS Steller sea lions experiencing temporary acoustic harassment resulting in behavioral responses. The loudest noise (from pile driving) will be episodic. Sheet pile pairs in Kotzebue took fewer than 5 minutes to install. More time is spent moving equipment and positioning the piles than actually driving them. The loudest noise produced, from the installation of the fender piles, is expected to last approximately two days each open water season. Consequently, even though pile driving will occur over three open water seasons, there will be significant amounts of time in which pile driving will not occur. Potential responses to pile installation and removal include increased stress, and/or short-term behavioral disturbance reactions such as changes in activity and vocalizations, avoidance or displacement, or apparent habituation. These reactions and behavioral changes are expected to be temporary and subside quickly when the exposure ceases. The primary mechanism by which these behavioral changes may affect the fitness of individual animals is through the animals' energy budget, time budget, or both (the two are related because foraging requires time). We expect that disturbed animals would leave the area during pile driving activities for other habitat located throughout Norton Sound or the Northern Bering Sea. The individual and cumulative energy costs of the behavioral responses we have discussed are not likely to reduce the energy budgets of seals and sea lions, and their probable exposure to noise sources are not likely to reduce their fitness.

6.3.2.2 Bowhead whale

The potential behavioral responses described for the pinnipeds also apply to the bowhead whale. Potential responses to pile installation and removal include increased stress, and/or short-term behavioral disturbance reactions such as changes in activity and vocalizations, avoidance or displacement. Because bowheads depend and use underwater sound to a greater extent than do pinnipeds, we assume that their sensitivity and hearing acuity is greater than pinnipeds and therefore they may have a stronger reaction to the noise than pinnipeds. The response we would expect is a deflection around the area causing an increase in energy expenditure.

6.3.3 Masking

6.3.3.1 Pinnipeds

Auditory interference, or masking, occurs when a noise is similar in frequency and intensity to (or more intense than) the auditory signal received by an animal while it is echolocating or listening for acoustic information from other animals. Masking can interfere with an animal’s ability to gather acoustic information about its environment, including information regarding predators, prey, conspecifics, and other environmental cues (Francis and Barber 2013). Because ringed seals, and phocids in general, can efficiently extract signals from background noise across a broad range of frequencies (Sills et al. 2015) it is less likely that they would experience difficulties related to masking during project activities.

Baleen whales echolocate to communicate, navigate, and detect predators and are therefore more susceptible to the effects of masking. Bearded seals, ringed seals, and Steller sea lions do not echolocate for these functions and are more likely to communicate with barks and trills and use their other senses and their highly developed vibrissae to hunt for prey when water is turbid or murky. The seals are most vocal during breeding season which occurs before project activities are expected to begin each spring.

The Port of Nome modification project will occur in a relatively busy harbor, where vessel sounds and dock activity already occur. Pile driving will increase the noise levels, but as explained in section 6.2.2, the pattern of pile driving will be episodic, as it only takes a few minutes to drive a pair of sheet piles, and the fender pile installation will occur over just a few days each year. The intermittent and condensed nature of the sound production indicates that there will be significant amounts of time when pile driving is not occurring.

6.3.3.2 Bowhead whale

Because baleen whales rely on echolocation to communicate, navigate, find prey, and detect predators, they are likely more vulnerable to the effects of sound masking than pinnipeds. Underwater noise will be increased around the Port of Nome as construction activities occur. The level of noise and the distance it can be heard will vary by activity. On prep days or days when only dredging is occurring, increased sound levels will not extend much beyond the port itself. When pile driving is occurring, sound will propagate much farther. We expect bowhead traveling through Norton Sound may have some natural sounds and/or communication masked for the intervals that pile driving is occurring.

6.3.3.3 Effects on Prey

The most likely impact to fish from pile driving in the project area would be temporary avoidance of the area. The duration of fish avoidance after completion of construction activities is unknown, but a rapid return to normal recruitment, distribution and behavior is expected. In general, impacts to marine mammal prey species are expected to be minor and temporary, due to the short project timeframe.

Although impact pile driving is known to cause fish mortalities, it has not been documented for vibratory pile driving (Burgess et al. 2005a, Popper et al. 2014). Prolonged (more than one hour), close (<10m) exposure could potentially affect the hearing of fish (Burgess et al. 2005a), but it is highly unlikely that this kind of exposure would occur in a natural setting where fish are free to swim away. As mentioned in section 6.1.1.6, the effects of sound on invertebrates is poorly documented (Hawkins and Popper 2017, Solé et al. 2023). It is unlikely that vibratory impact driving would have an effect on prey species used by ringed or bearded seals.

Bowhead whales feed primarily on zooplankton that is concentrated in areas of upwelling. Norton Sound has not been identified as an important feeding area for bowhead whales. We do not expect that pile driving activities at the Port of Nome will have an effect on the amount or quality of prey available to bowhead whales.

In summary, given the short daily duration of sound associated with the driving or extracting of individual piles and the relatively small areas being affected, we conclude the proposed action is not likely to have a measurable adverse effect on any populations of fish or invertebrate species (including zooplankton) that are prey for ringed seals, bearded seals, Steller sea lions, or bowhead whales. Thus, no short- or long-term effects are expected to these species as a consequence of pile driving effects on their prey.

7 CUMULATIVE EFFECTS

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

We searched for information on non-Federal actions reasonably certain to occur in the action area. We did not find any information about non-Federal actions other than what has already been described in the Environmental Baseline (Section 5 of this Opinion). We expect subsistence harvest of ringed and bearded seals, Western DPS Steller sea lions, and bowhead whales to continue. We expect bans on commercial marine mammal harvest in the United States will remain in place.

Reasonably foreseeable future state, local, or private actions include activities that relate to different scenarios of disturbance from vessel traffic. The Port of Nome is a regional hub port and receives regular activity from cargo ships, vessels towing barges, tankers, fishing boats, and passenger vessels (Figure 22). Vessel track-line data were displayed from January 2017 and June 2020 using the Automatic Identification System (AIS) (U.S Vessel Traffic website: https://livingatlas.arcgis.com/vessel-traffic, accessed April 2023). AIS tracking data displays that vessel use of Port of Nome is absent until Norton Sound is ice free. Vessels towing barges frequented the Port of Nome more often than any other vessel type. Track-lines from towing vessels occurred from May through November in some years. Fishing, cargo and tanker vessels used the Port from June through November.

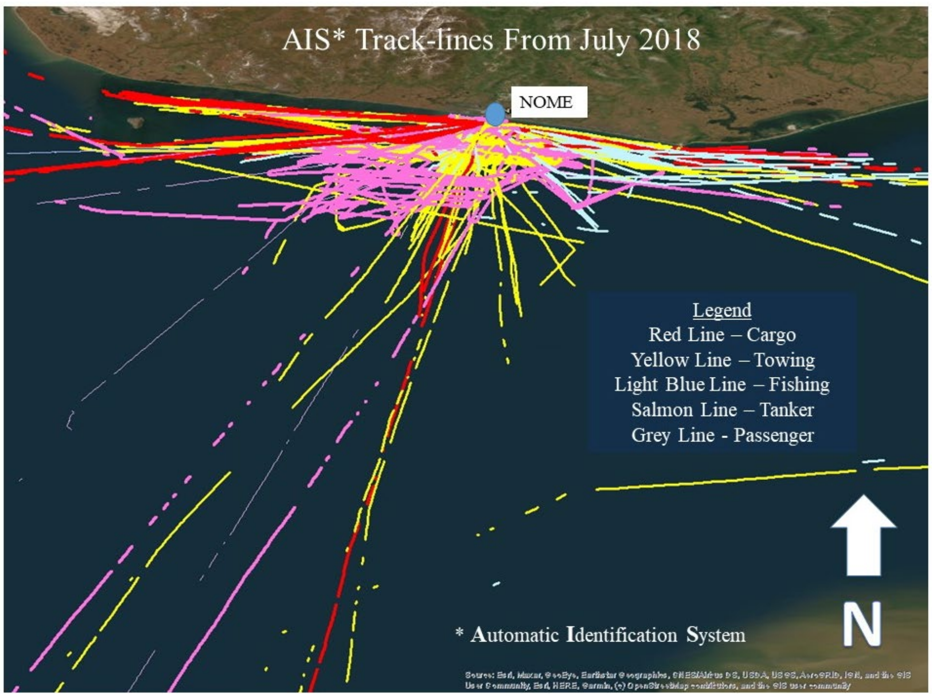

Figure 22. Vessels utilizing Port of Nome during July, 2018.

Reportedly, freight barges are the largest vessels that routinely transit the action area (USACE 2020), and the proposed action may ameliorate vessel restrictions imposed by insufficient channel depths and harbor area. This port modification will provide access opportunities for larger recreational and industrial vessels. Bulk fuel deliveries may be accomplished with deeper draft and larger vessels, delivering greater volumes of fuel directly to the dock and eliminating the need for lightering.

Decreasing sea ice levels will facilitate an increase in vessel traffic associated with oil and gas exploration, tourism, and open historically closed trade routes. The length of the navigation season in the Arctic has been growing by as much as 7-10 days annually, which, extrapolated over the next decade, could result in 2.5 months of additional navigation season over what was seen in 2019 (U.S. Committee on the Marine Transportation System 2019). The CMTS (U.S. Committee on the Marine Transportation System 2019) reported that the number of vessels operating in the Chukchi and Beaufort seas increased 128% from 2008 to 2018. The vessels included those used for research, natural resource exploration and extraction, commercial shipping, government/law enforcement/search and rescue, and tourism. For example, currently the port can only accommodate cruise ships with about 1,000 passengers. The expansion will allow cruise ships carrying up to 4,000 passengers to dock [20].

The Northern Sea Route shortens the transport distance from northern Europe to northeast Asia and northwest North America by up to 50% relative to the southern routes through Suez or Panama Canal. The Northwest Passage shortens the transit distance from western Europe to the Far East by 9,000 km in comparison to the conventional Panama Canal transit route (Khon et al. 2010). The two Arctic routes allow shipping companies to avoid tolls in the Suez and Panama Canals and provide routes for super ships that may be too large to use these canals and that are able to carry greater volumes of cargo (Nong et al. 2018). Of the 255 vessels that transited through the US Arctic and surrounding region from 2015-2017, over 50% were tug, towing, and cargo vessels.

In the projections developed by the CMTS regarding Arctic vessels, for the most plausible scenario, 72 vessels are expected to be active annually by 2030 in natural resource exploration and development, which is also the activity ranked as the largest contributor to projected traffic growth. More than 50% of this growth is expected to be from non-U.S. natural resource extraction (Russian exports of LNG and mineral extraction in Canada). By 2030 in the most plausible scenario, 28 vessels are expected to be rerouted through the Arctic and 17 additional vessels will be active with the expansion of the Arctic fleet (icebreakers, and ice-hardened cruise ships). However, these estimates are for large vessels only; they do not include small vessels such as those often used for commercial fishing, subsistence harvest, or lightering goods from large barges to docks or smaller vessels (U.S. Committee on the Marine Transportation System 2019).

In a parallel effort to predict the increase of vessel traffic through the Northwest Passage and the Northern Sea Route, Melia et al. (2016) used global climate models to project how sea ice loss might increase Arctic shipping. For a high-emission scenario, by late century, trans-Arctic shipping may be commonplace, with a season ranging from 4 to 8 months. For a low-emissions scenario, with global mean temperature stabilization of less than 2º C above preindustrial, the frequency of open water vessel transits still has the potential to double by midcentury with a season ranging from 2 to 4 months (Melia et al. 2016). As seasonal ice-free waters expand, the international commercial transport of goods and people in some Arctic areas is projected to

[20] https://apnews.com/article/alaska-arctic-port-nome-china-russia-588201b311513709404344fbc0d0e913. Viewed July 2023.

increase 100-500 percent by 2025 (Adams and Silber 2017).

In the first week of January 2021, a 908-foot Russian ice-hardened hull tanker with limited ice-breaking capabilities, carrying liquified natural gas (LNG) passed south through the Russian side of the Bering Strait, and two more followed the next week. The ships traversed the northern coast of Siberia, on the North Sea Route, in the middle of January with no icebreaker escort. The Nikolay Zubov, built in 2019, is one of a fleet of 15 Russian ships that are specially designed to transport LNG through thin sea ice. In May 2020, the first vessels of the season set a record for the earliest passage of the route by commercial tankers[21]. The passage of these ships is a clear indicator of how much the Arctic is changing and how vessel traffic will inevitably increase.

A report released by the Center for High North Logistics at Norway's Nord University Business School cited 62 transits through the Northern Sea Route between January 1 and December 9, 2020, compared to just 37 in all of 2019. An estimated 32 million tons of cargo passed along the route in 2020, compared to just 10.7 million tons in 2017. In 2019, the Russian government released a plan to have at least 40 Arctic vessels by 2035, many of them nuclear-powered icebreakers to keep the route passable by regular cargo ships for most of the year. While the US Coast Guard appears at least four years away from completing its first new icebreaker in 25 years[22], Russia's main operator of icebreakers, Rosatomflot, continues working on expanding its already substantial capabilities in the region. In February 2023, it signed a contract for the construction of the sixth and seventh nuclear icebreakers of the Arktika-class[2]. Three nuclear vessels of that type have been launched and are operating already. Two additional ones, Yakutia and Chukotka will follow in December 2024 and December 2026.

A greater number of vessels using the Arctic is expected to increase: air-borne emissions levels (CO_2 and black carbon), underwater noise, the potential for oil spills, introduction of nonnative species, and the probability of ships striking whales.

Commercial fishing generates income in the Norton Sound region and is expected to continue or increase in the future as sea ice area and volume declines. If commercial fishing expands northward, there may be increases in: interactions between marine mammals and fishing gear (in-use and derelict); competition for prey; and vessel interactions.

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

[21] http://www.nomenugget.net/news/russian-tanker-passes-through-bering-strait-midst-winter
[22] https://www.highnorthnews.com/en/new-us-icebreaker-delayed-until-2027-russia-orders-6th-and-7th-nuclear-icebreaker

environmental conditions in the action area are described in sections 4.2 and 5.1.

8 INTEGRATION AND SYNTHESIS

The Integration and Synthesis section is the final step of NMFS's assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 6) to the environmental baseline (Section 5) and the cumulative effects (Section 7) to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) result in appreciable reductions in the likelihood of both the survival or recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) result in the adverse modification or destruction of critical habitat as measured through direct or indirect alterations that appreciably diminish the value of designated critical habitat as a whole for the conservation of the species. These assessments are made in full consideration of the status of the species (Section 4).

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

As part of our risk analyses, we identified and addressed all potential stressors and considered all consequences of exposing listed species to all the stressors associated with the proposed action, individually and cumulatively, given that the individuals in the action area for this consultation are also exposed to other stressors in the action area and elsewhere in their geographic range.

8.1 Ringed and Bearded Seal Risk Analysis

As described in the Environmental Baseline (section 5) Beringia DPS bearded seals and Arctic ringed seals in the project area have been and will continue to be affected by the following:

- Climate change
    - Changes in snow and sea ice
    - Increased exposure to biotoxins (harmful algal blooms)
    - Exposure or increased susceptibility to new diseases
    - Changes in distribution of commercially important fish
    - Changes in the number of vessels and new shipping routes
- Direct mortality
    - Subsistence hunting
    - Entanglement and capture in fishing gear
    - Predation
- Exposure to pollutants and contaminants

- Scientific research

As discussed in sections 4.2.1, 4.2.2, and 5.1, effects to the ocean temperature, chemistry, and sea ice extent from climate change are considered the most important threats to ringed and bearded seals. Sea ice is extremely important to breeding success, and is also an important driver of prey availability. As ice and snow patterns change (i.e., either snow depth or ice extent declines), the chances of successful reproduction is reduced. Ringed seals require snow of sufficient depth for creation of subnivian lairs needed for pup survival (protection from elements and predation). For bearded seals, the presence of sea ice in April and May is considered a requirement for whelping and nursing young. Having sea ice over shallow water reduces the time and energy required for prey acquisition by the mother during whelping and gives the pup a resting platform. Both ringed and bearded seals need sea ice as a safe platform for their annual molt.

As sea ice declines, shipping will increase, increasing stress due to anthropogenic sound. If fish populations continue to move north into the northern Bering and Chukchi seas due to oceanic warming, commercial fisheries are likely to follow. The modifications at the Port of Nome could facilitate the expansion of commercial fisheries in the region. Greater geographic and temporal overlap between ringed and bearded seals and commercial fisheries would likely increase the risk of adverse effects resulting from capture in nets and entanglement in active and derelict fishing gear. We expect effects to these species due to changes in the commercial fisheries will be subject to future section 7 consultations as Fisheries Management Plans are developed or amended.

As discussed in section 5.1.1.3, vessel traffic is expected to increase throughout the Arctic as sea ice declines. We expect this will lead to more noise in the ocean and greater potential for vessel strike. However, as we have noted, vessel strike of pinnipeds has rarely been documented.

With warmer temperatures, toxins from harmful algal blooms have increased and an increasing number of species and individuals, including ringed and bearded seals have been affected (section 5.1.1.1). Exposure to new diseases or greater vulnerability to disease as a consequence of stress may occur as a consequence of climate change (section 5.1.1.2). Although a definitive cause of the UME for the ice seals has not been determined, it did occur during a period of warmer sea temperatures and unusually low sea ice years. As explained in section 4.2.1, ocean acidification may lead to water that is highly corrosive to calcifying organisms such as bivalves, crustaceans, and many forms of zooplankton such as copepods and pteropods, consequently affecting the prey of ringed and bearded seals. Although these consequences of climate change are foreseeable, climate-driven effects on ringed and bearded seals remain unquantifiable and immeasurable at this time.

Ringed and bearded seals are an important food and cultural resource in the Norton Sound region. We expect subsistence hunts targeting these animals will continue and will remain sustainable. Ringed and bearded seals evolved with predation from polar bears and we expect that predation will continue. As the distribution of all the species changes in response to changes in sea ice, it is not possible to predict if predation pressure will increase or decrease.

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 ringed and bearded seals. Based on the localized nature of small oil spills from the decks of vessels or equipment, the rapid weathering expected, and the safeguards in place to avoid and minimize oil spills, we conclude that the probability of the proposed action causing a small oil spill and exposing ringed and bearded seals is extremely small, and thus the effects are considered highly unlikely to occur.

Heavy metal and organic pollutants have been a long standing concern for bearded and ringed seals because of their importance as subsistence food for Native Alaskans. We expect contaminants will be an ongoing stressor for these species. Levels of arsenic are naturally high in the port of Nome. Arsenic can bioaccumulate in predators like seals and humans. The temporary suspension of sediment from the proposed project is not expected to increase arsenic levels in prey or predators over what has been occurring naturally and which has not yet led to definable health effects.

Scientific research has been ongoing on these species for over 20 years and is permitted to continue. Valuable information has been gained from this research and effects to the species are evaluated through the permitting and section 7 consultation process.

Minor stressors that we identified as a consequence of project activities are seafloor disturbance, contamination from arsenic, vessel strike from vessels related to port modification activities, in-water noise from dredging, and physical harm by the placement or movement of equipment (e.g. pile driver, dredger) or materials (e.g. sheet or pipe piles, fill) needed for the project. These stressors will have an immeasurably small effect or because of the mitigation measures will be unlikely to overlap spatially or temporally with ringed and bearded seals.

When considering the risk to these species we must put into context how the proposed activities at the Port of Nome may affect the populations. Although exact population numbers are not known for ringed or bearded seals, the population estimate for bearded seals is 300,000 or more (section 4.3.1) and for ringed seals it is 170,000 or more (section 4.3.3). During the open water season, individuals of these species are widely dispersed across the northern Bering, Chukchi, and Beaufort seas. Unlike Steller sea lions, they do not aggregate in large numbers in specific locations. The number of ringed and bearded seals that may occur near the Port of Nome when construction activities will occur cannot be known with certainty, but based on their life history and typical summer distribution, we expect the number of each species near the port to represent a very small percentage of their total population and to be mostly juveniles. We expect that a very small percentage of each population may be near the port at any given point in time because there is only a modest attractant (salmon staging near the mouth of the Snake River) and there are many deterrents (e.g. humans, vessels, human related noise, no ice). These facts combined with the implementation of the mitigation measures to reduce exposure of the individuals that may be in the area to harmful levels of sound, leads us to conclude that there will not be a population level effect to either bearded or ringed seals from the proposed Port of Nome modifications.

Based on the results of the exposure analysis (see Section 6), we expect ringed and bearded seals will be exposed to underwater noise from sheet pile driving and pipe pile driving. Although exposure will be minimized through mitigation measures ringed and bearded seals will be exposed to sound that is likely to result in Level B harassment (Table 15).

As we discussed in the Approach to the Assessment section of this opinion, an action that is not likely to reduce the fitness of an individual bearded or ringed seals would not be likely to reduce the viability of the populations those individual seals represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of such populations). For the same reasons, an action that is not likely to reduce the viability of those populations is not likely to increase the extinction probability of the species those populations comprise; in this case ringed and bearded seals. Based on the best information currently available, the proposed action is not expected to appreciably reduce the likelihood of survival or recovery of ringed or bearded seals.

8.2 Western DPS SSL Risk Analysis

Western DPS Steller sea lions have been and will be affected by many of the same stressors described above for ringed and bearded seals. However, the effects of climate change will be indirect rather than direct because Steller sea lions do not depend on the presence of sea ice for any life history stages. As described in the Environmental Baseline (section 5), the following stressors affect Western DPS Steller sea lions:

- Climate change
  - Increased exposure to biotoxins (harmful algal blooms)
  - Exposure or increased susceptibility to new diseases
  - Changes in distribution of commercially important fish
  - Changes in the number of vessels and new shipping routes
- Direct mortality
  - Subsistence hunting
  - Entanglement and capture in fishing gear
  - Predation
- Exposure to pollutants and contaminants

With warmer temperatures toxins from harmful algal blooms have increased (section 5.1.1). The marine heatwave that occurred from 2013-2015, caused an unprecedented harmful algal bloom (HAB) that extended from the Aleutian Islands to southern California resulting in mass strandings of marine mammals including Steller sea lions. Testing for biotoxins in marine mammals show that HAB toxins are present throughout Alaska waters at levels high enough to be detected in Steller sea lions and have the potential to impact marine mammal health. Exposure to new diseases or greater vulnerability to disease as a consequence of stress may occur as a consequence of climate change (section 5.1.2). As explained in section 4.2.1.3, ocean acidification may lead to water that is highly corrosive to calcifying organisms such as zooplankton, consequently affecting food webs and the prey that Steller sea lions depend on. Although these consequences of climate change are foreseeable, climate-driven effects on Steller sea lions remain unquantifiable and immeasurable at this time.

If fish populations continue to move north into the northern Bering and Chukchi seas due to oceanic warming, commercial fisheries are likely to follow. The modifications at the Port of Nome could facilitate the expansion of commercial fisheries in the northern Bering Sea region. A shift in commercial fishing northward could lead to a lessening of serious injury and mortality of Steller sea lions from interactions with commercial fishing gear around the Aleutian Islands and potentially a reduction of competition for fish. However, the changing distribution of fish could also mean that the Steller sea lions would have far fewer fish left in their feeding areas, including areas that are now defined as Steller sea lion special aquatic foraging areas.

As discussed in sections 5.1.3 and 7, vessel traffic is expected to increase throughout the Arctic as sea ice declines. We expect this will lead to more noise in the ocean and greater potential for vessel strikes. However, as we have noted, vessel strikes of Steller sea lions are rare. As shipping increases, the ocean will become increasingly noisy, and some masking of communication could occur.

Steller sea lions have been an important food and cultural resource to Native Alaskans, although the number taken is currently small compared to historical levels. Steller sea lions are a component of transient killer whales' diet. The predation risk to Steller sea lions is not expected to increase or decrease. This project is not expected to have an effect on predation risk.

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. Based on the localized nature of small oil spills from the decks of vessels or machinery, the rapid weathering expected, and the safeguards in place to avoid and minimize oil spills, we conclude that the probability of the proposed action causing a small oil spill and exposing Steller sea lions is extremely small, and thus the effects are considered highly unlikely to occur.

Heavy metal and organic pollutants have been documented in Steller sea lions, but levels have been declining as regulation has reduced the amount of synthetic organic compounds entering the environment. Levels of arsenic are naturally high in the port of Nome. However, the fish (primarily salmon) that Steller sea lions might target near the port of Nome would have little opportunity to bioaccumulate arsenic, and therefore, transfer of this metal to Steller sea lions is unlikely. The temporary suspension of sediment from the proposed project is not expected to increase arsenic levels in prey or predators over what has been occurring naturally and which has not yet led to documented health effects.

Scientific research has been ongoing on Steller sea lions for well over 20 years and will continue. Valuable information has been gained from this research and effects to the species due to research activities are evaluated through the permitting and section 7 consultation process. While some take of animals has been authorized for research activities, the amount of authorized take has not caused population-level effects nor reduced the likelihood of survival or recovery of the species.

Minor stressors that we identified as a consequence of project activities are seafloor disturbance, contamination, vessel strike from vessels involved in port modification activities, in-water noise from dredging, and physical harm by the placement or movement of equipment (e.g. pile driver, dredger) or materials (e.g. sheet or pipe piles, fill) needed for the project. These stressors will have an immeasurably small effect, or because of the mitigation measures, will be unlikely to overlap spatially or temporally with Steller sea lions.

When considering the risk to the Western DPS Steller sea lion, we must put into context how the proposed activities at the Port of Nome may affect the population. The population estimate for the Western DPS is approximately 53,000 (Section 4.3.5). During the open water season, individuals in this population are widely dispersed across the Gulf of Alaska, the Aleutian Islands, and the Bering Sea. However, they are most common and abundant around the Aleutian Islands, Kodiak, and eastern Gulf of Alaska. Steller sea lions aggregate in large numbers at specific rookeries and haulouts. No rookeries or haulouts have been identified near Nome. Salmon returning to the Snake River may attract individual Steller sea lions in late summer. The total number of Steller sea lions that may experience effects from the proposed project activities is expected to be extremely low and these individuals would represent a very small percentage of the total population. This fact, combined with the implementation of the mitigation measures to reduce exposure of the individuals that may be in the area to harmful levels of sound, leads us to conclude that there will not be a population level effect to Steller sea lions from the proposed Port of Nome modification project.

Based on the results of the exposure analysis (see Section 6), we expect Steller sea lions will be exposed to underwater noise from sheet pile driving and pipe pile driving. Although exposure will be minimized through mitigation measures, Western DPS Steller sea lions will be exposed to sound that is likely to result in Level B harassment (Table 15).

As we discussed in the Approach to the Assessment section of this opinion, an action that is not likely to reduce the fitness of an individual Steller sea lion 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 the same reasons, an action that is not likely to reduce the viability of those populations is not likely to increase the extinction probability of the species those populations comprise; in this case, Western DPS Steller sea lions. Based on the best information currently available, the proposed action is not expected to appreciably reduce the likelihood of survival or recovery of Steller sea lions.

8.3 Bowhead Whale Risk Analysis

Bowhead whales have been and will be affected by many of the same stressors described above for ringed seals, bearded seals, and Steller sea lions. Like Steller sea lions the effects of climate change will be indirect rather than direct because bowhead whales do not depend directly on the presence of sea ice for any life history stages. As described in the Environmental Baseline (section 5) bowhead whales in the project area have been and will continue to be affected by the following:

- Climate change
  - Changes in the distribution of sea ice
  - Increased exposure to biotoxins (harmful algal blooms)
  - Exposure or increased susceptibility to new diseases
  - Changes in distribution of commercially important fish
  - Changes in the number of vessels and new shipping routes
- Direct mortality
  - Subsistence hunting
  - Entanglement and capture in fishing gear
  - Predation
- Exposure to pollutants and contaminants
- Scientific research

As discussed in sections 4.2.1, 4.2.2, 5.1, effects to the ocean temperature, chemistry, and sea ice extent from climate change may affect bowhead whales, primarily through effects on their prey, increased vessels, and predation. Shifts in bowhead migration have been linked to changes in sea ice with whales staying farther north in years with less sea ice. Ocean acidification may lead to water that is highly corrosive to calcifying forms of zooplankton such as copepods and pteropods. Because bowhead whales primarily eat zooplankton, changes in the survival or quality of zooplankton could have a direct effect on bowhead fitness and survival.

Shipping in the Arctic is expected to increase as sea ice decreases. The Northern Sea Route along the northern Russian coast and the Northwest Passage through the Canadian Archipelago, both pass through Bering Strait. Typically the entire population of bowhead whales passes through Bering Strait each spring and fall between wintering and summering areas (Quakenbush et al. 2012). There are about 33 km between the west side of the Diomedes Islands and the Chukotka coast. Ships traveling along the coast between October and December could encounter a high proportion of the bowhead population. Ship strikes are the greatest source of mortality for North Atlantic right whales and bowhead whales may be as vulnerable to ship strikes as North Atlantic right whales due to their swimming speed and feeding behavior (i.e., "grazing" near the surface) (Reeves et al. 2012).

Increased vessel traffic will also increase oceanic noise. Bowheads rely on echolocation to communicate, find prey, and navigate. Increased vessel noise will likely have a much greater impact on this species than it will on the pinnipeds. Although we do not expect project-specific vessels to overlap spatially or temporally with bowhead whales, it is possible the port modifications could lead to larger vessels, both cargo and cruise ships, traveling farther north and increasing the probability of vessel strike and serious injury or mortality to individual whales. Currently, approximately 2 percent of bowhead whales show signs of vessel strike. However, an unknown number likely are struck and die without being seen and documented.

If fish populations continue to move north into the northern Bering and Chukchi seas due to oceanic warming, commercial fisheries are likely to follow. The modifications at the Port of Nome could facilitate the expansion of commercial fisheries in the region. Any geographic and temporal overlap between bowheads and commercial fisheries would increase the risk of adverse effects resulting from entanglement in active and derelict fishing gear. Effects to these species due to changes in the commercial fisheries will be subject to future section 7 consultations as Fishery Management Plans are developed or amended.

With warmer temperatures, toxins from harmful algal blooms have increased and an increasing number of species and individuals, including bowhead whales have been affected (section 5.1.1). Exposure to new diseases or greater vulnerability to disease as a consequence of stress may occur as a consequence of climate change (section 5.1.2). Although these consequences of climate change are foreseeable, climate-driven effects on bowhead whales remain unquantifiable and immeasurable at this time.

The villages of Kaktovik, Nuiqsut, Utqiagvik, Wainwright, Point Lay, Point Hope, Kivalina, Wales, Little Diomede, Gambell, and Savoonga are home to indigenous people who have hunted and depended on bowhead whales for food and cultural resources for millennia. We expect subsistence hunts targeting these animals will continue and will remain sustainable. Bowhead whales evolved with at least limited predation from transient killer whales. Predation pressure or stress from evasion from killer whales may increase as sea ice decreases. The proposed project will neither increase or decrease direct mortality risks.

Twelve percent of harvested bowhead whales showed signs of exposure to non-biodegradable marine debris, and the rate of encounter may be higher given some bowheads likely die each year and their entanglement scars are not documented. , However, the associated effects from this project would be minimal. Best management practices regarding waste management will reduce the impact of debris. Based on the localized nature of small oil spills from vessels or machinery, the rapid weathering expected, and the safeguards in place to avoid and minimize oil spills, we conclude that the probability of the proposed action causing a small oil spill and exposing bowhead whales is extremely small, and thus the effects are considered highly unlikely to occur.

Heavy metal and organic pollutants have been a long standing concern for bowhead whales because of their importance as subsistence food for Native Alaskans. With increased regulation around the use of synthetic organic contaminants we expect contaminate levels will decline. However, contaminates related to microplastics may emerge as a more serious and difficult problem for these filter feeding whales.

Scientific research has been ongoing on these species for over 20 years and will continue. Valuable information has been gained from this research and effects to the species are evaluated through the permitting and section 7 consultation process.

Minor stressors that we identified as a consequence of project activities are seafloor disturbance, contamination, vessel strike from vessels involved with port modification activities, in-water noise from dredging, and physical harm by the placement or movement of equipment (e.g. pile driver, dredger) or materials (e.g. sheet or pipe piles, fill) needed for the project. We do not expect that a bowhead whale would venture close enough to activities at the port of Nome to be exposed to any of these minor stressors.

When considering the risk to these species, we must put into context how the proposed activities at the Port of Nome may affect the population. The bowhead whale population is estimated to be between approximately 14,000 and 17,000 individuals (section 4.3.6) and may be at carrying capacity. During the open water season, nearly all of the population is north of Nome in the Beaufort and Chukchi seas. We expect the number of bowhead individuals that may occur near the project site will be no more than two over the three years of Phase 1. Effects from dredging activities that will occur during Phase 2 will not spatially and temporally overlap with bowheads, as the effects will largely be confined to the harbor itself. The number of bowheads that may be affected by the project (two) represent a very small percentage of the total population. These facts combined with the implementation of the mitigation measures to reduce exposure of individuals that may unexpectedly venture near Nome leads us to conclude that there will not be a population level effect to bowhead whales from the proposed Port of Nome modifications.

As we discussed in the Approach to the Assessment section of this opinion, an action that is not likely to reduce the fitness of an individual bowhead whale would not be likely to reduce the viability of the population those individuals represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of such populations). For the same reasons, an action that is not likely to reduce the viability of those populations is not likely to increase the extinction probability of the species those populations comprise; in this case bowhead whales. Based on the best information currently available, the proposed action is not expected to appreciably reduce the likelihood of survival or recovery of bowhead whales.

We concluded in the Effects of the Action (Section 6 of this opinion, Table 15) that ESA-listed species will be exposed to Level B behavioral take. Because of the shutdown zones prescribed by mitigation measures, we expect no MMPA Level A exposure. Behavioral harassment from pile driving sounds during Phase 1 (over three years) of the Port of Nome Modification project can be reasonably expected to occur as follows:

- Beringia DPS bearded seal = 2,985 individuals.
- Arctic ringed seal = 153 individuals.
- Western DPS SSL = 255 individuals.
- Bowhead whales = 2 total for three years.

While we analyzed all the effects from Phase 1 and 2 of the Port of Nome Modification project, we determined that take is reasonably certain to occur only during the pile driving associated with Phase 1. These estimates represent the maximum number of takes that may be expected to 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. Pile driving will occur outside of the sensitive breeding season for ringed seals, bearded seals, and Steller sea lions, but pile driving sounds are likely to cause some individual pinnipeds to respond with changes in their behavioral states. Those responses are not likely to alter the physiology, behavioral ecology, or social dynamics of individuals in ways or to a degree that would reduce their fitness.

The primary mechanism by which the behavioral changes may affect the fitness of individual animals is through the animal's energy budget, time budget, or both; the two are related because foraging requires time. The individual and cumulative energy costs of the behavioral responses we have discussed are likely to increase the energy budgets of ringed seals, bearded seals, Steller sea lions and bowhead whales. The expected responses (tolerance, avoidance, and short-term vigilance behavior) to pile driving sound are not likely to reduce their fitness.

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 opinion that the proposed action is not likely to jeopardize the continued existence of Beringia DPS bearded seal, Arctic ringed seal, bowhead whale, and Western DPS Steller sea lion. NMFS also concludes that the proposed action is not likely to adversely affect North Pacific right whales, Mexico DPS humpback whales, Western North Pacific DPS humpback whales, Western North Pacific DPS gray whales, fin whales, or Cook Inlet beluga whales and is not likely to adversely affect designated critical habitat for Cook Inlet beluga whales, Mexico DPS humpback whales, Western North Pacific DPS humpback whales, North Pacific right whales, Steller sea lions, Arctic ringed seals, or Beringia DPS bearded seals.

10 INCIDENTAL TAKE STATEMENT

This Incidental Take Statement exempts that same level of take for each of the three years of Phase 1, one third of the total for all three years (Table 15). The total take exempted for this project is shown in Table 16.

Pile driving activities will be halted as soon as possible when it appears an ESA-listed species is approaching the Level A shutdown zone and before it reaches the Level A isopleth. No Level A take of marine mammals is authorized in this opinion.

Table 16. Authorized take for the Port of Nome Phase I (three years).

Species	Authorized Take by acoustic harassment
Arctic Ringed Seal	153
Beringia DPS Bearded Seal	2985
Western DPS Steller Sea Lion	255
Bowhead Whale	2

10.1 Effect of the Take

Studies of marine mammals and responses to acoustic exposure to pile driving and construction activities have shown that marine mammals are likely to exhibit behavioral responses. Only take by acoustic harassment is authorized by this incidental take statement. No serious injury or mortalities are anticipated or authorized as part of this proposed action. Although the biological significance of acoustic harassment in these species remains unknown, we assumed that exposure to received levels of impulsive sound greater than 160 dB, and non-impulsive sound greater than 120 dB is likely to disrupt one or more behavioral patterns that are essential to an individual animal's life history, potentially affecting survival or fitness. However, any behavioral responses of individual marine mammals to such sound sources are not expected to affect the reproduction, survival, or recovery of these species as a whole.

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

10.2 Reasonable and Prudent Measures

"Reasonable and prudent measures" are measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take." (50 CFR 402.02). Failure to comply with

RPMs (and the terms and conditions that implement them) may invalidate the take exemption and result in unauthorized take.

RPMs are distinct from the mitigation measures that are included in the proposed action (described in Section 2.2). We presume that the mitigation measures will be implemented as described in this opinion. The failure to do so will constitute a change to the action that may require reinitiation of consultation pursuant to 50 CFR § 402.16.

The RPMs included below, along with their implementing terms and conditions, are designed to minimize and monitor the impact of incidental take that might otherwise result from the proposed action. NMFS concludes that the following RPMs are necessary and appropriate to minimize and monitor the incidental take of Arctic ringed seals, Beringia DPS bearded seals, Western DPS Steller sea lions, and bowhead whales resulting from the proposed action.

1. The NMFS Permits Division and USACE will ensure that activities associated with this project will have minimal impacts upon Arctic ringed seals, Beringia DPS Bearded seals, Western DPS Steller sea lions, and bowhead whales.
2. The USACE will implement a comprehensive monitoring program to ensure that Arctic ringed seals, Beringia DPS Bearded seals, Western DPS Steller sea lions, and bowhead whales are not taken in numbers or in a manner not anticipated by this opinion, and to submit a final report to NMFS Alaska Region evaluating the mitigation measures and the results of the monitoring program.

10.3 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. These terms and conditions are in addition to the mitigation measures included in the proposed action, as set forth in Section 2.1.2 of this opinion. The NMFS Permit 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 ITS (50 CFR § 402.14(i)(3))).

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

These terms and conditions constitute no more than a minor change to the proposed action because they are consistent with the basic design of the proposed action.

To carry out RPM #1 and #2: NMFS Permits Division and USACE, or its authorization holder must:

1. Submit a draft marine mammal monitoring and mitigation plan consistent with Section 2.1.2 of this Biological Opinion to NMFS Alaska Region for review and approval prior to commencing in-water construction activities.

2. Implement all mitigation measures as described in opinion, the final IHA and the marine mammal monitoring and mitigation plan.

3. Immediately reports incidents of marine mammal injury, mortality, or unauthorized take to NMFS Alaska Region (akr.section7@noaa.gov). Mortalities must also be reported to the Marine Mammal Stranding Hotline at 877-925-7773 (Table 4).

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:

1. That the USACE use bubble curtains during sheet pile installation to reduce underwater sound while vibratory pile driving.

2. That the USACE conduct sound source verification studies to assess sound generated by types and sizes of piles driven with and/or without the use of bubble curtains during Project activities.

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 USACE should notify NMFS of any conservation recommendations they implement in their final action.

12 REINITIATION OF CONSULTATION

As provided in 50 CFR § 402.16, reinitiation of consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action on listed species or designated critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount of incidental take is exceeded, section 7 consultation must be reinitiated immediately (50 CFR § 402.14(i)(4)).

13 DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

13.1 Utility

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

This consultation will be posted on the NMFS Alaska Region website 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

Adams, J. D., and G. K. Silber. 2017. 2015 vessel activity in the Arctic. Page 171 p. U.S. Dept. of Commerce, NOAA, NMFS, Office of Protected Resources, Silver Spring, MD.

Aguilar, A., A. Borrell, and P. J. H. Reijnders. 2002. Geographical and temporal variation in levels of organochlorine contaminants in marine mammals. Marine Enviornmental Research **53**:425-452.

Allen, B. M., and R. P. Angliss. 2010. Alaska marine mammal stock assessments, 2009. Page 276 p. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Andersen, M. S., K. A. Forney, T. V. N. Cole, T. Eagle, R. Angliss, K. Long, L. Barre, L. V. Atta, D. Borggaard, T. Rowles, B. Norberg, J. Whaley, and L. Engleby. 2008. Differentiating serious and non-serious injury of marine mammals: Report of the Serious Injury Technical Workshop, 10-13 September 2007, Seattle, Washington, NOAA Technical Memorandum NMFS-OPR-39. 94 p.

Avio, C. G., S. Gorbi, M. Milan, M. Benedetti, D. Fattorini, G. d'Errico, M. Pauletto, L. Bargelloni, and F. Regoli. 2015. Pollutants bioavailability and toxicological risk from microplastics to marine mussels. Environmental Pollution **198**:211-222.

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.

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**.

Baulch, S., and C. Perry. 2014. Evaluating the impacts of marine debris on cetaceans. Marine Pollution Bulletin **80**:210-221.

Becker, P. R., E. A. Mackey, R. Demiralp, M. M. Schantz, B. J. Koster, and S. A. Wise. 1997. Concentrations of chlorinated hydrocarbons and trace elements in marine mammal tissues archived in the U.S. National Biomonitoring Specimen Bank. Chemosphere **34**:2067-2098.

Becker, P. R., E. A. Mackey, M. M. Schantz, R. Demiralp, R. R. Greenberg, B. J. Koster, S. A. Wise, and D. C. G. Muir. 1995. Concentrations of chlorinated hydrocarbons, heavy metals and other elements in tissues banked by the Alaska Marine Mammal Tissue Archival Project. U.S. Department of Commerce, NOAA and National Institute of Standards and Technology, Silver Spring, MD.

Bengtson, J. L., L. M. Hiruki-Raring, M. A. Simpkins, and P. L. Boveng. 2005. Ringed and bearded seal densities in the eastern Chukchi Sea, 1999–2000. Polar Biology **28**:833-845.

Bergmann, M., V. Wirzberger, T. Krumpen, C. Lorenz, S. Primpke, M. B. Tekman, and G. Gerdts. 2017. High quantities of microplastic in Arctic deep-sea sediments from the HAUSGARTEN Observatory. Environmental Science and Technology **51**:11000-11010.

Besseling, E., E. Foekema, J. Van Franeker, M. Leopold, S. Kühn, E. B. Rebolledo, E. Heße, L. Mielke, J. IJzer, and P. Kamminga. 2015. Microplastic in a macro filter feeder: humpback whale *Megaptera novaeangliae*. Marine Pollution Bulletin **95**:248-252.

Besseling, E., B. Wang, M. Lürling, and A. A. Koelmans. 2014. Nanoplastic affects growth of *S. obliquus* and reproduction of *D. magna*. Environmental Science and Technology **48**:12336-12343.

BOEM. 2011. Biological Evaluation for Oil and Gas Activities on the Beaufort and Chukchi Sea Planning Areas. OCS EIS/EA BOEMRE 2011. Alaska Outer Continental Shelf.

Bolam, S. G., and H. L. Rees. 2003. Minimizing impacts of maintenance dredged material disposal in the coastal environment: a habitat approach. Environmental Management **32**:171-188.

Bolton, J. L., G. M. Ylitalo, P. Chittaro, J. C. George, R. Suydam, B. T. Person, J. B. Gates, K. A. Baugh, T. Sformo, and R. Stimmelmayr. 2020. Multi-year assessment (2006–2015) of persistent organic pollutant concentrations in blubber and muscle from Western Arctic bowhead whales (Balaena mysticetus), North Slope, Alaska. Marine Pollution Bulletin **151**.

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

Born, E. W., J. Teilmann, M. Acquarone, and F. F. Riget. 2004. Habitat use of ringed seals (*Phoca hispida*) in the North Water Area (North Baffin Bay). Arctic **57**:129-142.

Boveng, P. L., M. Cameron, P. B. Conn, and E. Moreland. 2017a. Abundance Estimates of Ice-Associated Seals: Bering Sea Populations that Inhabit the Chukchi Sea During the Open-Water Period, Final Report Page 119 p. plus appendices. U.S. Dept. of Interior, Bureau of Ocean Energy Management, Alaska OCS Region, Anchorage, AK.

Boveng, P. L., M. Cameron, P. B. Conn, and E. Moreland. 2017b. Abundance Estimates of Ice-Associated Seals: Bering Sea Populations that Inhabit the Chukchi Sea During the Open-

Water Period, Final Report. Page 119 p. plus appendices. U.S. Dept. of Interior, Bureau of Ocean Energy Management, Alaska OCS Region, Anchorage, AK.

Boyce, D. G., M. R. Lewis, and B. Worm. 2010. Global phytoplankton decline over the past century. Nature **466**:591-596.

Bratton, G. R., C. B. Spainhour, W. Flory, M. Reed, and K. Jayko. 1993. Presence and potential effects of contaminants. Pages 701-744 *in* J. J. Burns, J. J. Montague, and C. J. Cowles, editors. The Bowhead Whale. The Society for Marine Mammalogy, Special Publication Number 2, Lawrence, KS.

Broadwater, M. H., F. M. Van Dolah, and S. E. Fire. 2018. Vulnerabilities of marine mammals to harmful algal blooms. Pages 191-222 *in* S. E. Shumway, J. M. Burkholder, and S. L. Morton, editors. Harmful Algal Blooms: A Compendium Desk Reference. John Wiley and Sons, Hoboken, NJ.

Brower, A., A. Willoughby, and M. Ferguson. 2022a. Distribution and relative abundance of bowhead whales and other marine mammals in the western Beaufort Sea, 2020.

Brower, A., A. Willoughby, and M. Ferguson. 2022b. Distribution and relative abundance of bowhead whales and other marine mammals in the western Beaufort Sea, 2020. Page 155 p. U.S. Dept. of Commerce, National Oceanic and Oceanic Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

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

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

Burgess, W. C., S. B. Blackwell, and R. Abbott. 2005a. Underwater acoustic measurements of vibratory pile driving at the pipeline 5 crossing in the Snohomish River, Everett, Washington.

Burgess, W. C., S. B. Blackwell, and R. Abbott. 2005b. Underwater acoustic measurements of vibratory pile driving at the pipeline 5 crossing in the Snohomish River, Everett, Washington. Greeneridge Report 322-2. Prepared for URS Corporation. 40 pp.

Burkow, I. C., and R. Kallenborn. 2000. Sources and transport of persistent pollutants to the Arctic. Toxicology letters **112**:87-92.

Burns, J. J. 1967. The Pacific bearded seal. Pittman-Robertson Project Report W-6-R and W-14-R, Alaska Department of Fish and Game, Juneau, AK.

Burns, J. J. 1981. Bearded seal *Erignatus barbatus* Erxleben, 1777. Handbook of Marine Mammals Volume 2: Seals:145-170.

Burns, J. J., and T. J. J. Eley. 1976. The natural history and ecology of the bearded seal (*Erignathus barbatus*) and the ringed seal (*Phoca (Pusa) hispida*). Pages 263-294 Environmental Assessment of the Alaskan Continental Shelf. Principal Investigators' Reports for the Year Ending March 1976, U.S. Department of Commerce, NOAA, Boulder, CO.

Burns, J. J., and K. J. Frost. 1979. The natural history and ecology of the bearded seal, *Erignathus barbatus*. Environmental Assessment of the Alaskan Continental Shelf, Final Reports **19**:311-392.

Burns, J. J., and S. J. Harbo. 1972. An aerial census of ringed seals, northern coast of Alaska. Arctic **25**:279-290.

Calkins, D. G. 1986. Chapter 17: Marine Mammals. Page 527−558 *in* D. W. Hood and S. T. Zimmerman, editors. The Gulf of Alaska, Physical Environment and Biological Resources. Government Printing Office, Washington, D. C.

Calkins, D. G. 1996. Movements and habitat use of female Steller sea lions in Southeastern Alaska. Pages 110-134 Steller Sea Lion Recovery Investigations in Alaska, 1992-1994. Alaska Department of Fish and Game, Divison of Wildlife Conservation, Wildlife Technical Bulletin No. 13.

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

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

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

CalTrans. 2015. Technical guidance for assessment and mitigation of the hydroacoustic effects of pile driving on fish: Appendix I – Compendium of pile driving sound data. Report Number: CTHWANP-RT-15-306.01.01, Division of Environmental Analysis, California Department of Transportation, Sacramento, CA.

Cameron, M., and P. Boveng. 2007. Abundance and distribution surveys for ice seals aboard USCG *Healy* and the *Oscar Dyson,* April 10-June 18, 2007. Pages pages 12-14. Alaska

Fisheries Science Center Quarterly Report, Seattle, WA.

Cameron, M., and P. Boveng. 2009. Habitat use and seasonal movements of adult and sub-adult bearded seals. Pages pages 1-4. Alaska Fisheries Science Center Quarterly Report, Seattle, WA.

Cameron, M. F., J. L. Bengtson, P. L. Boveng, J. K. Jansen, B. P. Kelly, S. P. Dahle, E. A. Logerwell, J. E. Overland, C. L. Sabine, G. T. Waring, and J. M. Wilder. 2010. Status review of the bearded seal (*Erignathus barbatus*). Page 246 p. U.S. Department of Commerce, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Cameron, M. F., K. J. Frost, Jay M. Ver Hoef, B. G. A., A. V. Whiting, J. Goodwin, and P. L. Boveng. 2018. Habitat selection and seasonal movements of young bearded seals (*Erignathus barabatus*) in the Bering Sea. PLoS One **13**:e0192743.

Carlens, H., C. Lydersen, B. A. Krafft, and K. M. Kovacs. 2006. Spring haul-out behavior of ringed seals (*Pusa hispida*) in Kongsfjorden, Svalbard. Marine Mammal Science **22**:379-393.

Carretta, J. V., B. Delean, V. Helker, M. M. Muto, J. Greenman, K. Wilkinson, D. Lawson, J. Viezbicke, and J. Jannot. 2020. Sources of human-related injury and mortality for U.S. Pacific west coast marine mammal stock assessments, 2014-2018. Page 147 p. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

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

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

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

Citta, J. J., G. A. Breed, S. R. Okonnen, M. L. Druckenmiller, L. Quakenbush, J. C. George, B. Adams, W. Maslowski, R. Osinski, and J. Olnes. 2023. Shifts in bowhead whale distribution, behavior, and condition following rapid sea ice change in the Bering sea. Continental Shelf Research:104959.

Citta, J. J., L. Quakenbush, and C. George. 2020. Distribution and behavior of Bering-Chukchi-Beaufort bowhead whales as inferred by telemetry. Pages 31-56 *in* J. C. George and J. G. M. H. Thewissen, editors. The Bowhead Whale: Balaena mysticetus: biology and human Interactions. Elsevier Science & Technology, San Diego, CA.

Citta, J. J., L. T. Quakenbush, J. C. George, R. J. Small, M. P. Heide-Jorgensen, H. Brower, B. Adams, and L. Brower. 2012. Winter Movements of Bowhead Whales (*Balaena mysticetus*) in the Bering Sea. Arctic **65**:13-34.

Clark, C. W., and J. H. Johnson. 1984. The sounds of the bowhead whale, *Balaena mysticetus*, during the spring migrations of 1979 and 1980. Canadian Journal of Zoology-Revue Canadienne De Zoologie **62**:1436-1441.

Clarke, J., A. Brower, M. Ferguson, A. Willoughby, and A. Rotrock. 2020. Distribution and relative abundance of marine mammals in the eastern Chukchi Sea, eastern and western Beaufort Sea, and Amundsen Gulf, 2019 annual report. U.S. Dept. of Interior, Bureau of Ocean Energy Management (BOEM), Alaska OCS Region, Anchorage, AK.

Clarke, J., K. Stafford, S. E. Moore, B. Rone, L. Aerts, and J. Crance. 2013. Subarctic cetaceans in the southern Chukchi Sea: Evidence of recovery or response to a changing ecosystem. Oceanography **26**:136-149.

Clarke, J. T., A. A. Brower, M. C. Ferguson, A. S. Kennedy, and A. L. Willoughby. 2015. Distribution and Relative Abundance of Marine Mammals in the Eastern Chukchi and Western Beaufort Seas, 2014.*in* A. F. S. C. National Marine Mammal Laboratory, NMFS, NOAA, editor., Seattle, WA.

Clarke, J. T., C. L. Christman, A. A. Brower, and M. C. Ferguson. 2012. Distribution and relative abundance of marine mammals in the Alaskan Chukchi and Beaufort Seas, 2011 Annual Report. Page 358 p. Report prepared by U.S. Dept. of Commerce, NOAA, NMFS, Alaska Fisheries Science Center, National Marine Mammal Laboratory for the U.S. Dept. of Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Alaska OCS Region, Anchorage, AK.

Cleator, H. J., and I. Stirling. 1990. Winter distribution of bearded seals (*Erignathus barbatus*) in the Penny Strait area, Northwest Territories, as determined by underwater vocalizations. Canadian Journal of Fisheries and Aquatic Sciences **47**:1071-1076.

Cleator, H. J., I. Stirling, and T. G. Smith. 1989. Underwater vocalizations of the bearded seal (*Erignathus barbatus*). Canadian Journal of Zoology **67**:1900-1910.

Coffing, M., C. L. Scott, and C. J. Utermohle. 1998. The subsistence harvest of seals and seal lions by Alaska natives in three communities of the Yukon-Kuskokwim Delta, Alaska, 1997-98. Alaska Department of Fish and Game, Division of Subsistence, Juneau, Alaska.

Cole, M., P. Lindeque, C. Halsband, and T. S. Galloway. 2011. Microplastics as contaminants in the marine environment: a review. Marine Pollution Bulletin **62**:2588-2597.

Conn, Paul B., Jay M. Ver Hoef, Brett T. McClintock, Erin E. Moreland, Josh M. London, Michael F. Cameron, Shawn P. Dahle, and Peter L. Boveng. 2014. Estimating multispecies abundance using automated detection systems: ice-associated seals in the Bering Sea. Methods in Ecology and Evolution **5**:1280-1293.

Cooke, J. G. 2018. Abundance estimates for western North Pacific gray whales for use with stock structure hypotheses of the range-wide review of the population structure and status of North Pacific gray whales. IWC SC/67b/ASI.

Cooke, J. G. 2020. Population assessment update for Sakhalin gray whales. Paper WGWAP-21/13 at the 21st meeting of the Western Gray Whale Advisory Panel.

Cooke, J. G., D. W. Weller, A. L. Bradford, O. Sychenko, A. M. Burdin, A. R. Lang, and R. L. Brownell Jr. 2017. Population assessment update for Sakhalin gray whale, with reference to stock identity.

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

Cowan, D. F., and B. E. Curry. 2002. Histopathological assessment of dolphins necropsied onboard vessels in the eastern tropical Pacific tuna fishery. Page 31 NMFS SWFSC Administrative Report. Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, La Jolla, California.

Crance, J. L., C. L. Berchok, J. Bonnel, and A. M. Thode. 2015. Northeasternmost record of a North Pacific fin whale (*Balaenoptera physalus*) in the Alaskan Chukchi Sea. Polar Biology **38**:1767-1773.

Crawford, J. A., K. J. Forst, L. Quakenbush, and A. Whiting. 2012. Different habitat use strategies by subadult and adult ringed seals (*Phoca hispida*) in the Bering and Chukchi seas. Polar Biology **35**:241-255.

Crawford, J. A., L. T. Quakenbush, and J. J. Citta. 2015. A comparison of ringed and bearded seal diet, condition and productivity between historical (1975–1984) and recent (2003–2012) periods in the Alaskan Bering and Chukchi seas. Progress in Oceanography **136**:133-150.

Crecelius, E. A., C. W. Apts, and B. K. Lasorsa. 1990. Concentrations of metals in Norton Sound seawater samples and human hair samples, 1989. Page 35 p. U. S. Dept. of Interior, Minerals Management Service, Alaska OCS Region, Sequim, WA.

Crowley, T. J. 2000. Causes of climate change over the past 1000 years. Science **289**:270-277.

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. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-254, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, La Jolla, California.

Dahlheim, M. E., and P. A. White. 2010. Ecological aspects of transient killer whales *Orcinus orca* as predators in southeastern Alaska. Wildlife Biology **16**:308-322.

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

Dehn, L.-A., G. G. Sheffield, E. H. Follmann, L. K. Duffy, D. L. Thomas, and T. M. O'Hara. 2007. Feeding ecology of phocid seals and some walrus in the Alaskan and Canadian Arctic as determined by stomach contents and stable isotope analysis. Polar Biology **30**:167-181.

Dehnhardt, G., B. Mauck, and H. Bleckmann. 1998. Seal whiskers detect water movements. Nature **394**:235-236.

Delarue, J., B. Martin, D. Hannay, and C. L. Berchok. 2013. Acoustic occurrence and affiliation of fin whales detected in the Northeastern Chukchi Sea, July to October 2007-10. Arctic **66**:159-172.

Delean, B. J., V. T. Helker, M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, J. E. Jannot, and N. C. Young. 2020. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2013-2017. Page 86 p *in* S. United States. National Marine Fisheries, C. Alaska Fisheries Science, O. Alaska Regional, R. West Coast, and C. Northwest Fisheries Science, editors. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Derocher, A. E., N. J. Lunn, and I. Stirling. 2004. Polar bears in a warming climate. (Ursus maritimus). Integrative and Comparative Biology **44**:163-176.

Derraik, J. G. 2002a. The pollution of the marine environment by plastic debris: a review. Marine Pollution Bulletin **44**:842-852.

Derraik, J. G. B. 2002b. The pollution of the marine environment by plastic debris: a review. Marine Pollution Bulletin **44**:842-852.

Dickerson, C., K. J. Reine, and D. G. Clarke. 2001. Characterization of underwater sounds produced by bucket dredging operations. U.S. Army Corps of Engineers Dredging Operations and Environmental Research, Vicksburg, MS.

Dietrich, K. S., V. R. Cornish, K. S. Rivera, and T. A. Conant. 2007. Best practices for the collection of longline data to facilitate research and analysis to reduce bycatch of protected species: report of a workshop held at the International Fisheries Observer Conference Sydney, Australia, November 8, 2004.*in* N. U.S. Dep. Commer., NMFS, editor.

Dietz, R., F. Riget, E. W. Born, C. Sonne, P. Grandjean, M. Kirkegaard, M. T. Olsen, G. Asmund, A. Renzoni, and H. Baagøe. 2006. Trends in mercury in hair of greenlandic polar bears (*Ursus maritimus*) during 1892−2001. Environmental Science and Technology **40**:1120-1125.

Dietz, R., C. Sonne, N. Basu, B. Braune, T. O'Hara, R. J. Letcher, T. Scheuhammer, M. Andersen, C. Andreasen, and D. Andriashek. 2013. What are the toxicological effects of mercury in Arctic biota? Science of The Total Environment **443**:775-790.

Doney, S. C., V. J. Fabry, R. A. Feely, and J. A. Kleypas. 2009. Ocean Acidification: The Other CO_2 Problem. Annual Review of Marine Science **1**:169-192.

Doney, S. C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. J. Sydeman, and L. D. Talley. 2012. Climate change impacts on marine ecosystems. Annual Reviews in Marine Science **4**:11-37.

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

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

Ellison, W. T., C. W. Clark, and G. C. Bishop. 1987. Potential Use of Surface Reverberation by Bowhead Whales, *Balaena mysticetus*, in Under-ice Navigation: Preliminary Considerations. Report of the International Whaling Commission **37**:329-332.

Elsner, R., D. Wartzok, N. B. Sonafrank, and B. P. Kelly. 1989. Behavioral and physiological reactions of arctic seals during under-ice pilotage. Canadian Journal of Zoology **67**:2506-2513.

Erbe, C. 2002. Hearing Abilities of Baleen Whales. Defense Research and Development Canada, Ottawa, Ont.

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

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

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

Fadely, B. S., B. W. Robson, J. T. Sterling, A. Greig, and K. A. Call. 2005. Immature Steller sea lion (*Eumetopias jubatus*) dive activity in relation to habitat features of the eastern Aleutian Islands. Fisheries Oceanography **14**:243-258.

Fang, C., R. Zheng, F. Hong, Y. Jiang, J. Chen, H. Lin, L. Lin, R. Lei, C. Bailey, and J. Bo. 2021. Microplastics in three typical benthic species from the Arctic: Occurrence, characteristics, sources, and environmental implications. Environmental Research **192**:110326.

Fang, C., R. Zheng, Y. Zhang, F. Hong, J. Mu, M. Chen, P. Song, L. Lin, H. Lin, and F. Le. 2018. Microplastic contamination in benthic organisms from the Arctic and sub-Arctic regions. Chemosphere **209**:298-306.

Fay, F. H., J. L. Sease, and R. L. Merrick. 1990. Predation on a ringed seal, *Phoca hispida*, and a black guillemot, *Cepphus grylle*, by a Pacific walrus, *Odobenus rosmarus divergens*. Marine Mammal Science **6**:348-350.

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.

Fedoseev, G. A. 1965. The ecology of the reproduction of seals on the northern part of the Sea of Okhotsk. Izvestiya TINRO **65**:212-216.

Fedoseev, G. A. 1984. Population structure, current status, and perspective for utilization of the ice-inhabiting forms of pinnipeds in the northern part of the Pacific Ocean. Pages 130-146 *in* A. V. Yablokov, editor. Marine mammals. Nauka, Moscow.

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

Feely, R. A., C. L. Sabine, K. Lee, W. Berelson, J. Kleypas, V. J. Fabry, and F. J. Millero. 2004.

Impact of anthropogenic CO2 on the CaCO3 system in the oceans. Science **305**:362-366.

Feltz, E. T., and F. H. Fay. 1966. Thermal requirements in vitro of epidermal cells from seals. Cryobiology **3**:261-264.

Ferdinando, P. M. 2019. Assessment of heavy metals in subsistence-harvested Alaskan marine mammal body tissues and vibrissae. Master's thesis. Nova Southeastern University, Fort Lauderdale, FL.

Ferguson, M. C., D. L. Miller, J. T. Clarke, A. L. Brower, A. Willoughby, and A. Rotrock. 2022. Spatial modeling, parameter uncertainty, and precision of density estimates from line-transect surveys: a case study with Western Arctic bowhead whales. IWC.

Ferguson, M. C., J. M. Waite, C. Curtice, J. T. Clarke, and J. Harrison. 2015. 7. Biologically Important Areas for Cetaceans Within US Waters-Aleutian Islands and Bering Sea Region. Aquatic Mammals **41**:79.

Ferguson, S. H., I. Stirling, and P. McLoughlin. 2005. Climate change and ringed seal (Phoca hispida) recruitment in western Hudson Bay. Marine Mammal Science **21**:121-135.

Fey, S. B., A. M. Siepielski, S. Nusslé, K. Cervantes-Yoshida, J. L. Hwan, E. R. Huber, M. J. Fey, A. Catenazzi, and S. M. Carlson. 2015. Recent shifts in the occurrence, cause, and magnitude of animal mass mortality events. Proceedings of the National Academy of Sciences **112**:1083-1088.

Finneran, J. J., and A. K. Jenkins. 2012. Criteria and thresholds for U.S. Navy acoustic and explosive effects analysis. Space and Naval Warfare Systems Center Pacific ,53610 Catalina Boulevard ,San Diego,CA, 92147.

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**:1819-1826.

Fiscus, C. H., and G. A. Baines. 1966. Food and Feeding Behavior of Steller and California Sea Lions. Journal of Mammalogy **47**:195-200.

Fredette, T., and G. French. 2004. Understanding the physical and environmental consequences of dredged material disposal: history in New England and current perspectives. Marine Pollution Bulletin **49**:93-102.

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

Freitas, C., K. M. Kovacs, R. A. Ims, M. A. Fedak, and C. Lydersen. 2008. Ringed seal post-moulting movement tactics and habitat selection. Oecologia **155**:193-204.

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

Frost, K. J., and L. F. Lowry. 1981. Ringed, Baikal and Caspian seals. Handbook of marine mammals **2**:29-54.

Gaden, A., S. H. Ferguson, L. Harwood, H. Melling, and G. A. Stern. 2009. Mercury trends in ringed seals (*Phoca hispida*) from the western Canadian Arctic since 1973: associations with length of ice-free season. Environmental Science and Technology **43**:3646-3651.

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**:1773-1780.

Gende, S., A. N. Hendrix, and J. Schmidt. 2018. Somewhere between acceptable and sustainable: When do impacts to resources become too large in protected areas? Biological Conservation **223**:138-146.

George, J., M. L. Druckenmiller, K. L. Laidre, R. Suydam, and B. Person. 2015. Bowhead whale body condition and links to summer sea ice and upwelling in the Beaufort Sea. Progress in Oceanogprahy **136**:250-262.

George, J. C., C. Clark, G. M. Carroll, and W. T. Ellison. 1989. Observations on the ice-breaking and ice navigation behavior of migrating bowhead whales (*Balaena mysticetus*) near Point Barrow, Alaska, Spring 1985. Arctic **42**:24-30.

George, J. C., C. Nicolson, S. Drobot, J. Maslanik, and R. Suydam. 2006. Sea ice density and bowhead whale body condition preliminary findings [Poster] Society for Marine Mammalogy, San Diego, CA.

George, J. C., G. Sheffield, D. J. Reed, B. Tudor, R. Stimmelmayr, B. T. Person, T. Sformo, and R. Suydam. 2017. Frequency of injuries from line entanglements, killer whales, and ship strikes on Bering-Chukchi-Beaufort seas bowhead whales. Arctic **70**:37-46.

George, J. C., J. E. Zeh, R. Suydam, and C. Clark. 2004. Abundance and population trend (1978-2001) of western arctic bowhead whales surveryed near Barrow, Alaska. Marine Mammal Science **20**:755-773.

Georgette, S., M. Coffing, C. Scott, and C. Utermohle. 1998. The subsistence harvest of seals and sea lions by Alaska natives in the Norton Sound-Bering Strait region, Alaska, 1996-97. Alaska Department of Fish and Game, Division of Subsistence, Juneau, Alaska.

Geyer, R., J. R. Jambeck, and K. L. Law. 2017. Production, use, and fate of all plastics ever made. Science Advances **3**:e1700782.

Givens, G. H., C. George, R. Suydam, B. Tudor, A. L. Von Duyke, B. Person, and K. Scheimreif. 2021. Correcting the 2019 survey abundance of Bering-Chukchi-Beaufort Seas bowhead whales for disturbance from powered skiffs. IWC.

Gjertz, I., K. Kovacs, C. Lydersen, and Ø. Wiig. 2000. Movements and diving of bearded seal (*Erignathus barbatus*) mothers and pups during lactation and post-weaning. Polar Biology **23**:559-566.

Grebmeier, J. M., J. E. Overland, S. E. Moore, E. V. Farley, E. C. Carmack, L. W. Cooper, K. E. Frey, J. H. Helle, F. A. McLaughlin, and S. L. McNutt. 2006. A major ecosystem shift in the northern Bering Sea. Science **311**:1461-1464.

Green, G. A., M. Blees, P. G. Cartier, L. R. Olson, and J. B. Leavitt. 2018. Marine mammal monitoring and mitigation 90-day report: Quintillion 2017 subsea cable system phase 1 installation program. Anchorage, Alaska.

Guarino, M.-V., L. C. Sime, D. Schröeder, I. Malmierca-Vallet, E. Rosenblum, M. Ringer, J. Ridley, D. Feltham, C. Bitz, and E. J. Steig. 2020. Sea-ice-free Arctic during the Last Interglacial supports fast future loss. Nature Climate Change **10**:928-932.

Halliday, W. D., N. LeBaron, J. J. Citta, J. Dawson, T. Doniol-Valcroze, M. Ferguson, S. H. Ferguson, S. Fortune, L. A. Harwood, M. P. Heide-Jørgensen, E. V. Lea, L. Quakenbush, B. G. Young, D. Yurkowski, and S. J. Insley. 2022. Overlap between bowhead whales (*Balaena mysticetus*) and vessel traffic in the North American Arctic and implications for conservation and management. Biological Conservation **276**:109820.

Hammill, M. O., and T. G. Smith. 1989. Factors affecting the distribution and abundance of ringed seal structures in Barrow Strait, Northwest Territories. Canadian Journal of Zoology **67**:2212-2219.

Hannay, D. E., J. Delarue, X. Mouy, B. S. Martin, D. Leary, J. N. Oswald, and J. Vallarta. 2013. Marine mammal acoustic detections in the northeastern Chukchi Sea, September 2007–July 2011. Continental Shelf Research **67**:127-146.

Harvey, M., D. Gauthier, and J. Munro. 1998. Temporal changes in the composition and abundance of the macro-benthic invertebrate communities at dredged material disposal sites in the Anse à Beaufils, Baie des Chaleurs, Eastern Canada. Marine Pollution Bulletin **36**:41-55.

Harwood, L. A., T. G. Smith, J. C. Auld, H. Melling, and Yurkowski. 2015. Seasonal movements and diving of ringed seals, Pusa hispida, in the western Canadian Arctic, 1999-2001 and 2010-11. Arctic **68**:193-209.

Harwood, L. A., and I. Stirling. 1992. Distribution of ringed seals in the southeastern Beaufort Sea during late summer. Canadian Journal of Zoology-Revue Canadienne De Zoologie **70**:891-900.

Hawkins, A. D., A. E. Pembroke, and A. N. Popper. 2015. Information gaps in understanding the effects of noise on fishes and invertebrates. Reviews in Fish Biology and Fisheries **25**:39-64.

Hawkins, A. D., and A. N. Popper. 2017. A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates. ICES Journal of Marine Science **74**:635-651.

Heise, K., L. G. Barrett-Lennard, E. Saulitis, C. Matkin, and D. Bain. 2003. Examining the evidence for killer whale predation on Steller sea lions in British Columbia and Alaska. Aquatic Mammals **29**:325-334.

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. 2019. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. Page 71 p. U. S. Dept. of Commerce, NOAA, NMFS, Alaska Fisheries Science Center, Seattle, WA.

Heptner, L. V. G., K. K. Chapskii, V. A. Arsenev, and V. T. Sokolov. 1976. Bearded seal. *Erignathus barbatus* (Erxleben, 1777). Pages 166-217 *in* L. V. G. Heptner, N. P. Naumov, and J. Mead, editors. Mammals of the Soviet Union. Vysshaya Shkola Publishers, Moscow, Russia.

Herráez, P., E. Sierra, M. Arbelo, J. Jaber, A. E. De Los Monteros, and A. Fernández. 2007. Rhabdomyolysis and myoglobinuric nephrosis (capture myopathy) in a striped dolphin. Journal of Wildlife Diseases **43**:770-774.

Hezel, P. J., X. Zhang, C. M. Bitz, B. P. Kelly, and F. Massonnet. 2012. Projected decline in spring snow depth on Arctic sea ice caused by progressively later autumn open ocean freeze-up this century. Geophysical Research Letters **39**.

Higdon, J. W., and S. H. Ferguson. 2009. Loss of Arctic sea ice causing punctuated change in sightings of killer whales (Orcinus orca) over the past century. Ecological Applications **19**:1365-1375.

Hinzman, L. D., N. D. Bettez, W. R. Bolton, F. S. Chapin, M. B. Dyurgerov, C. L. Fastie, B. Griffith, R. D. Hollister, A. Hope, H. P. Huntington, A. M. Jensen, G. J. Jia, T. Jorgenson, D. L. Kane, D. R. Klein, G. Kofinas, A. H. Lynch, A. H. Lloyd, A. D. McGuire, F. E. Nelson, W. C. Oechel, T. E. Osterkamp, C. H. Racine, V. E. Romanovsky, R. S. Stone, D. A. Stow, M. Sturm, C. E. Tweedie, G. L. Vourlitis, M. D. Walker, D. A. Walker, P. J. Webber, J. M. Welker, K. S. Winker, and K. Yoshikawa. 2005. Evidence and Implications of Recent Climate Change in Northern Alaska and

Other Arctic Regions. Climatic Change **72**:251-298.

Hirai, H., H. Takada, Y. Ogata, R. Yamashita, K. Mizukawa, M. Saha, C. Kwan, C. Moore, H. Gray, and D. Laursen. 2011. Organic micropollutants in marine plastics debris from the open ocean and remote and urban beaches. Marine Pollution Bulletin **62**:1683-1692.

Holmes, A. L., S. S. Wise, C. E. C. Goertz, J. L. Dunn, F. M. D. Gulland, T. Gelatt, K. B. Beckmen, K. Burek, S. Atkinson, M. Bozza, R. Taylor, T. Z. Zheng, Y. W. Zhang, A. M. Aboueissa, and J. P. Wise. 2008. Metal tissue levels in Steller sea lion (*Eumetopias jubatus*) pups. Marine Pollution Bulletin **56**:1416-1421.

Holst, M., I. Stirling, and K. A. Hobson. 2001. Diet of ringed seals (Phoca hispida) on the east and west sides of the North Water Polynya, northern Baffin Bay. Marine Mammal Science **17**:888-908.

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*). General and comparative endocrinology **148**:260-272.

Huntington, H. P. 2000. Traditional ecological knowledge of seals in Norton Bay, Alaska. Report submitted to Elim-Shaktoolik-Koyuk Marine Mammal Commission and the National Marine Fisheries Service by Huntington Consulting, Eagle River, AK.

Huntington, H. P., S. L. Danielson, F. K. Wiese, M. Baker, P. Boveng, J. J. Citta, A. De Robertis, D. M. Dickson, E. Farley, and J. C. George. 2020. Evidence suggests potential transformation of the Pacific Arctic ecosystem is underway. Nature Climate Change **10**:342-348.

Hyvärinen, H. 1989. Diving in darkness: whiskers as sense organs of the ringed seal (*Phoca hispida saimensis*). Journal of Zoology **218**:663-678.

Ice Seal Committee. 2019. The subsistence harvest of ice seals in Alaska – a compilation of existing information, 1960-2017.

IPCC. 2013. Summary for policymakers. Pages 3-39 *in* D. Q. T. F. Stocker, G. K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P. M. Midgley, editor. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York.

IPCC. 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II, and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland.

IPCC. 2019. Summary for Policymakers. Pages 1-36 *in* H.-O. Pörtner, D. C. Roberts, V.

Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. Weyer, editors. IPCC Special Report on the Ocean and Cryosphere in a Changing Climate. Intergovernmental Panel on Climate Change.

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

Jambeck, J. R., R. Geyer, C. Wilcox, T. R. Siegler, M. Perryman, A. Andrady, R. Narayan, and K. L. Law. 2015. Plastic waste inputs from land into the ocean. Science **347**:768-771.

Jewett, S. C., and A. S. Naidu. 2000. Assessment of heavy metals in red king crabs following offshore placer gold mining. Marine Pollution Bulletin **40**:478-490.

Jiang, L., R. A. Feely, B. R. Carter, D. J. Greeley, D. K. Gledhill, and K. M. Arzayus. 2015. Climatological distribution of aragonite saturation state in the global oceans. Global Biogeochemical Cycles **29**:1656-1673.

Kastelein, R. A., R. Van Schie, W. C. Verboom, and D. de Haan. 2005. Underwater hearing sensitivity of a male and a female Steller sea lion (*Eumetopias jubatus*). Journal of the Acoustical Society of America **118**:1820-1829.

Kelly, B. P., O. H. Badajos, M. Kunnasranta, J. R. Moran, M. Martinez-Bakker, D. Wartzok, and P. Boveng. 2010a. Seasonal home ranges and fidelity to breeding sites among ringed seals. Polar Biology **33**:1095-1109.

Kelly, B. P., J. L. Bengtson, P. L. Boveng, M. F. Cameron, S. P. Dahle, J. K. Jansen, E. A. Logerwell, J. E. Overland, C. L. Sabine, G. T. Waring, and J. M. Wilder. 2010b. Status review of the ringed seal (*Phoca hispida*). Page 250 p. U.S. Dept. of Commerce, NOAA, NMFS, Alaska Fisheries Science Center.

Kelly, B. P., L. Quakenbush, and J. R. Rose. 1986. Ringed seal winter ecology and effects of noise disturbance. Institute of Marine Science, Fairbanks, Alaska.

Kelly, B. P., and L. T. Quakenbush. 1990. Spatiotemporal use of lairs by ringed seals (*Phoca hispida*). Canadian Journal of Zoology **68**:2503-2512.

Kelly, B. P., and D. Wartzok. 1996. Ringed seal diving behavior in the breeding season. Canadian Journal of Zoology-Revue Canadienne De Zoologie **74**:1547-1555.

Kenney, R. D., M. A. M. Hyman, R. E. Owen, G. P. Scott, and H. E. Winn. 1986. Estimation of prey densities required by western North Atlantic right whales. Marine Mammal Science **2**:1-13.

Khon, V. C., I. Mokhov, M. Latif, V. A. Semenov, and W. Park. 2010. Perspectives of Northern Sea Route and Northwest Passage in the twenty-first century. Climatic Change **100**:757-

768.

Kight, C. R., and J. P. Swaddle. 2011. How and why environmental noise impacts animals: an integrative, mechanistic review. Ecology Letters **14**:1052-1061.

Kovacs, K. M. 2007. Background document for development of a circumpolar ringed seal (*Phoca hispida*) monitoring plan. Marine Mammal Commission, L'Oceanogràfic, Valencia, Spain.

Krafft, B. A., C. Lydersen, K. M. Kovacs, I. Gjertz, and T. Haug. 2000. Diving behaviour of lactating bearded seals (Erignathus barbatus) in the Svalbard area. Canadian Journal of Zoology **78**:1408-1418.

La Daana, K. K., K. Gardfeldt, T. Krumpen, R. C. Thompson, and I. O'Connor. 2020. Microplastics in sea ice and seawater beneath ice floes from the Arctic Ocean. Scientific Reports **10**:1-11.

La Daana, K. K., K. Gårdfeldt, O. Lyashevska, M. Hassellöv, R. C. Thompson, and I. O'Connor. 2018. Microplastics in sub-surface waters of the Arctic Central Basin. Marine Pollution Bulletin **130**:8-18.

Labansen, A. L., C. Lydersen, T. Haug, and K. M. Kovacs. 2007. Spring diet of ringed seals (Phoca hispida) from northwestern Spitsbergen, Norway. ICES (International Council for the Exploration of the Seas) Journal of Marine Science **64**:1246-1256.

Laidre, K. L., M. P. Heide-Jorgensen, and T. G. Nielsen. 2007. Role of the bowhead whale as a predator in West Greenland. Marine Ecology Progress Series **346**:285-297.

Laist, D. W. 1997. Impacts of marine debris: entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. Pages 99-139 *in* J. M. Coe and D. B. Rogers, editors. Marine Debris - sources, impacts, and solutions. Springer-Verlag, New York.

Laist, D. W., A. R. Knowlton, J. G. Mead, A. S. Collet, and M. Podesta. 2001. Collisions between ships and whales. Marine Mammal Science **17**:35-75.

Laurel, B. J., M. E. Hunsicker, L. Ciannelli, T. P. Hurst, J. Duffy-Anderson, R. O'Malley, and M. Behrenfeld. 2021. Regional warming exacerbates match/mismatch vulnerability for cod larvae in Alaska. Progress in Oceanography **193**.

Law, K. L. 2017. Plastics in the marine environment. Annual Review of Marine Science **9**:205-229.

Lee, J. S., S. Tanabe, H. Umino, R. Tatsukawa, T. R. Loughlin, and D. C. Calkins. 1996. Persistent organochlorines in Steller sea lion (*Eumetopias jubatusi*) from the bulk of

Alaska and the Bering Sea, 1976-1981. Marine Pollution Bulletin **32**:535-544.

Lefebvre, K. A., L. Quakenbush, E. Frame, K. B. Huntington, G. Sheffield, R. Stimmelmayr, A. Bryan, P. Kendrick, H. Ziel, T. Goldstein, J. A. Snyder, T. Gelatt, F. Gulland, B. Dickerson, and V. Gill. 2016. Prevalence of algal toxins in Alaskan marine mammals foraging in a changing arctic and subarctic environment. Harmful Algae **55**:13-24.

Lentfer, J. W. 1972. Alaska polar bear research and management. Morges, Switzerland.

Lischka, S., and U. Riebesell. 2012. Synergistic effects of ocean acidification and warming on overwintering pteropods in the Arctic. Global change biology **18**:3517-3528.

Lithner, D., Å. Larsson, and G. Dave. 2011. Environmental and health hazard ranking and assessment of plastic polymers based on chemical composition. Science of The Total Environment **409**:3309-3324.

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.

Loeng, H., K. Brander, E. Carmack, S. Denisenko, K. Drinkwater, B. Hansen, K. Kovacs, P. Livingston, F. McLaughlin, and E. Sakshaug. 2005. Marine Ecosystems. Arctic Climate Impact Assessment (ACIA), Cambridge.

Loughlin, T. R. 1997. Using the phylogeographic method to identify Steller sea lion stocks. Molecular Genetics of Marine Mammals **Spec. Pub. 3**:159-171.

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**:729-740.

Loughlin, T. R., J. T. Sterling, R. L. Merrick, J. L. Sease, and A. E. York. 2003. Diving behavior of immature Steller sea lions (*Eumetopias jubatus*). Fishery Bulletin **101**:566-582.

Loughlin, T. R., and A. E. York. 2000. An accounting of the sources of Steller sea lion, *Eumetopias jubatus*, mortality. Marine Fisheries Review **62**:40-45.

Lowry, L. F. 1993. Foods and feeding ecology. Pages 201-238 *in* J. J. Burns, J. J. Montague, and C. J. Cowles, editors. The Bowhead Whale. Allen Press, Inc., Lawrence, KS.

Lowry, L. F., K. J. Frost, and J. J. Burns. 1980. Variability in the diet of ringed seals, Phoca hispida, in Alaska. Canadian Journal of Fisheries and Aquatic Sciences **37**:2254-2261.

Lowry, L. F., G. Sheffield, and J. C. George. 2004. Bowhead whale feeding in the Alaskan Beaufort Sea, based on stomach contents analyses. Journal of Cetacean Research Management **6**:215–223.

Lusher, A. L., V. Tirelli, I. O'Connor, and R. Officer. 2015. Microplastics in Arctic polar waters: the first reported values of particles in surface and sub-surface samples. Scientific Reports **5**:1-9.

Lüthi, D., M. Le Floch, B. Bereiter, T. Blunier, J.-M. Barnola, U. Siegenthaler, D. Raynaud, J. Jouzel, H. Fischer, K. Kawamura, and T. F. Stocker. 2008. High-resolution carbon dioxide concentration record 650,000–800,000 years before present. Nature **453**:379-382.

Luvonga, C., C. A. Rimmer, L. L. Yu, and S. B. Lee. 2020. Organoarsenicals in seafood: occurrence, dietary exposure, toxicity, and risk assessment considerations–A review. Journal of agricultural and food chemistry **68**:943-960.

Lydersen, C. 1991. Monitoring ringed seal (*Phoca hispida*) activity by means of acoustic telemetry. Canadian Journal of Zoology **69**:1178-1182.

Lydersen, C. 1998. Status and biology of ringed seals (*Phoca hispida*) in Svalbard. Pages 46-62 *in* M. P. Heide-Jorgensen and C. Lydersen, editors. Ringed Seals in the North Atlantic. NAMMCO Scientific Publications.

Lydersen, C., and M. O. Hammill. 1993. Diving in ringed seal (Phoca hispida) pups during the nursing period. Canadian Journal of Zoology **71**:991-996.

Lydersen, C., M. O. Hammill, and K. M. Kovacs. 1994. Diving activity in nursing bearded seal (Erignathus barbatus) pups. Canadian Journal of Zoology **72**:96-103.

Lydersen, C., P. M. Jensen, and E. Lydersen. 1987. Studies of the ringed seal *(Phoca hispida)* population in the Van Mijen fiord, Svalbard, in the breeding period 1986.

Lydersen, C., and K. M. Kovacs. 1999. Behaviour and energetics of ice-breeding, North Atlantic phocid seals during the lactation period. Marine Ecology Progress Series **187**:265-281.

Lydersen, C., and T. G. Smith. 1989. Avian predation on ringed seal *Phoca hispida* pups. Polar Biology **9**:489-490.

Macdonald, R. W., B. Morton, and S. C. Johnnessen. 2003. A review of marine environmental contaminant issues in the North Pacific: The dangers and how to identify them. Environ. Rev. **11**:103-139.

MacGillivray, A., G. Warner, and C. McPherson. 2015. Alaska DOT Hydroacoustic Pile Driving Noise Study: Kake Monitoring Results. JASCO Document 01093, Version 2.0, Technical report by JASCO Applied Sciences for Alaska Department of Transportation and Public

Facilities.

Malek, J. C., and V. R. Cornish. 2019. Co-management of marine mammals in Alaska: a case study-based review. Page 58 p. Marine Mammal Commission, Bethesda, MD.

Maniscalco, J. M., C. O. Matkin, D. Maldini, D. G. Calkins, and S. Atkinson. 2007. Assessing killer whale predation on Steller sea lions from field observations in Kenai Fjords, Alaska. Marine Mammal Science **23**:306-321.

Maniscalco, J. M., P. Parker, and S. Atkinson. 2006. Interseasonal and interannual measures of maternal care among individual Steller sea lions (*Eumetopias jubatus*). Journal of Mammalogy **87**:304-311.

Manning, T. H. 1974. Variation in the skull of the bearded seal, Erignathus barbatus (Erxleben). Biological Papers of the University of Alaska **16**:1-21.

Marshall, C. D., H. Amin, K. M. Kovacs, and C. Lydersen. 2006. Microstructure and innervation of the mystacial vibrissal follicle-sinus complex in bearded seals, *Erignathus barbatus* (Pinnipedia: Phocidae). The Anatomical Record Part A: Discoveries in Molecular, Cellular, and Evolutionary Biology **288**:13-25.

Marshall, C. D., K. M. Kovacs, and C. Lydersen. 2008. Feeding kinematics, suction and hydraulic jetting capabilities in bearded seals (*Erignathus barbatus*). Journal of Experimental Biology **211**:699-708.

Mato, Y., T. Isobe, H. Takada, H. Kanehiro, C. Ohtake, and T. Kaminuma. 2001. Plastic resin pellets as a transport medium for toxic chemicals in the marine environment. Environmental Science and Technology **35**:318-324.

McCabe, R. M., B. M. Hickey, R. M. Kudela, K. A. Lefebvre, N. G. Adams, B. D. Bill, F. M. Gulland, R. E. Thomson, W. P. Cochlan, and V. L. Trainer. 2016. An unprecedented coastwide toxic algal bloom linked to anomalous ocean conditions. Geophysical Research Letters **43**:10,366-310,376.

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.

McKenzie, J., and K. M. Wynne. 2008. Spatial and temporal variation in the diet of Steller sea lions in the Kodiak Archipelago, 1999 to 2005. Marine Ecology Progress Series **360**:265-283.

McQueen, A. D., B. C. Suedel, and J. L. Wilkens. 2019. Review of the adverse biological effects of dredging-induced underwater sounds. WEDA Journal of Dredging **17**:1-22.

Meier, W. N., D. Perovich, S. Farrell, C. Haas, S. Hendricks, A. A. Petty, M. Webster, D. Divine, S. Gerland, and e. al. 2021. Sea Ice *In* Arctic Report Card 2021, T.A. Moon, M.L Druckenmiller, and R.L. Thoman, eds. Pages 32-40.

Melia, N., K. Haines, and E. Hawkins. 2016. Sea ice decline and 21st century trans-Arctic shipping routes. Geophysical Research Letters **43**:9720-9728.

Melnikov, V., and I. Zagrebin. 2005. Killer whale predation in coastal waters of the Chukotka Peninsula. Marine Mammal Science **21**:550-556.

Merrick, R. L., M. K. Chumbley, and G. V. Byrd. 1997. Diet diversity of Steller sea lions (*Eumetopias jubatus*) and their population decline in Alaska: a potential relationship. Canadian Journal of Fisheries and Aquatic Sciences **54**:1342-1348.

Merrick, R. L., and T. R. Loughlin. 1997. Foraging behavior of adult female and young-of-the-year Steller sea lions in Alaskan waters. Canadian Journal of Zoology **75**:776-786.

Miller, G., R. Elliott, T. Thomas, V. Moulton, and W. Koski. 2002. Distribution and numbers of bowhead whales in the eastern Alaskan Beaufort Sea during late summer and autumn, 1979-2000. Pages 2002-2012 *in* W. Richardson and D. Thomson, editors.

Miller, M. E., M. Hamann, and F. J. Kroon. 2020. Bioaccumulation and biomagnification of microplastics in marine organisms: a review and meta-analysis of current data. PLoS One **15**:e0240792.

Mocklin, J. A. 2009. Evidence of bowhead whale feeding behavior from aerial photography. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Service, Seattle, WA.

Moore, S. E., J. C. George, G. Sheffield, J. Bacon, and C. J. Ashjian. 2010. Bowhead Whale Distribution and Feeding near Barrow, Alaska, in Late Summer 2005-06. Arctic **63**:195-205.

Moore, S. E., and H. P. Huntington. 2008. Arctic marine mammals and climate change: impacts and resilience. Ecological Applications **18**.

Moore, S. E., and K. L. Laidre. 2006. Trends in sea ice cover within habitats used by bowhead whales in the western Arctic. Ecological Applications **16**:932-944.

Moreland, E., M. Cameron, and P. Boveng. 2013. Bering Okhotsk Seal Surveys (BOSS) joint U.S.-Russian aerial surveys for ice-associated seals, 2012-13 Page 6 p. AFSC Quarterly Report, Seattle, WA.

Mossner, S., and K. Ballschmiter. 1997. Marine mammals as global pollution indicators for organochlorines. Chemosphere **34**:1285-1296.

Mueter, F. J., and M. A. Litzow. 2008. Sea ice retreat alters the biogeography of the Bering Sea continental shelf. Ecological Applications **18**:309-320.

Muto, M. M., V. T. Helker, R. P. Angliss, B. A. Allen, P. L. Boveng, J. M. Breiwick, M. F. Cameron, P. J. Clapham, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. 2018. Alaska marine mammal stock assessments, 2017. Page 382 p. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Muto, M. M., V. T. Helker, R. P. Angliss, P. L. Boveng, J. M. Breiwick, M. F. Cameron, P. Clapham, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, K. L. Sweeney, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. 2019. Alaska marine mammal stock assessments, 2018. Page 390 p. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Muto, M. M., V. T. Helker, B. J. Delean, R. P. Angliss, P. L. Boveng, J. M. Breiwick, B. M. Brost, M. F. Cameron, P. J. Clapham, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, R. C. Hobbs, Y. V. Ivaschenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, K. L. Sweeney, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. 2020. Alaska marine mammal stock assessments, 2019. Page 395 p. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Muto, M. M., V. T. Helker, B. J. Delean, N. C. Young, J. C. Freed, R. P. Angliss, N. A. Friday, P. L. Boveng, J. M. Breiwick, B. M. Brost, M. F. Cameron, P. J. Clapham, J. L. Crance, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, K. T. Goetz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, K. L. Sweeney, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. 2021. Alaska marine mammal stock assessments, 2020. Page 398 p. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Muto, M. M., V. T. Helker, B. J. Delean, N. C. Young, J. C. Freed, R. P. Angliss, N. A. Friday, P. L. Boveng, J. M. Breiwick, B. M. Brost, M. F. Cameron, P. J. Clapham, J. L. Crance, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, K. T. Goetz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, K. L. Sweeney, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. 2022. Alaska marine mammal stock assessments, 2021. Page 398 p. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Nedwell, J., A. Turnpenny, J. Langworthy, and B. Edwards. 2003. Measurements of underwater noise during piling at the Red Funnel Terminal, Southampton, and observations of its effect on caged fish. Subacoustics LTD. Report **558**.

Neilson, J. L., C. M. Gabriele, A. S. Jensen, K. Jackson, and J. M. Straley. 2012. Summary of reported whale-vessel collisions in Alaskan waters. Journal of Marine Biology **2012**:Article ID 106282.

Nelson, M. A., L. T. Quakenbush, B. D. Taras, and Ice Seal Committee. 2019. Subsistence harvest of ringed, bearded, spotted, and ribbon seals in Alaska is sustainable. Endangered Species Research **40**:1-16.

Nelson, R. R., J. J. Burns, and K. J. Frost. 1984. The bearded seal (*Erignathus barbatus*). Pages 1-6 *in* J. J. Burns, editor. Marine Mammal Species Accounts, Wildlife Technical Bulletin. Alaska Department of Fish and Game, Juneau, AK.

NMFS. 2008. Recovery plan for the Steller sea lion (*Eumetopias jubatus*). Eastern and Western Distinct Population Segments (*Eumetopias jubatus*). Revision. Page 325 p. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Silver Spring, MD.

NMFS. 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-55, 178 p.

NMFS. 2020a. 5-year review: summary and evaluation of western Distinct Population Segment Steller sea lion *Eumetopias jubatus*. Page 61 p. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Region, Protected Resources Division, Juneau, AK.

NMFS. 2020b. Endangered Species Act Section 7 programmatic biological and conference opinion on construction and operation of up to six new icebreakers to support Coast Guard Missions in the Arctic and Antarctic. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, Endangered Species Act Interagency Cooperation Division, Silver Spring, MD. September 3, 2020.

Nong, D., A. M. Countryman, T. Warziniack, and E. K. Grey. 2018. Arctic sea routes: potential new pathways for nonindigenous species spread. Arctic **71**:269-280.

Noongwook, G., H. P. Huntington, J. C. George, Native Village Savoonga, and Native Village Gambell. 2007. Traditional knowledge of the bowhead whale (*Balaena mysticetus*) around St. Lawrence Island, Alaska. Arctic **60**:47-54.

Notz, D., and J. Stroeve. 2016. Observed Arctic sea-ice loss directly follows anthropogenic CO_2 emission. Science **354**:747-750.

NRC. 2003. Ocean Noise and Marine Mammals. National Research Council, Ocean Study Board, National Academy Press, Washington, D.C.

Obbard, R. W., S. Sadri, Y. Q. Wong, A. A. Khitun, I. Baker, and R. C. Thompson. 2014. Global warming releases microplastic legacy frozen in Arctic Sea ice. Earth's Future **2**:315-320.

Oceana and Kawerak. 2014. Bering Strait marine life and subsistence use data synthesis.

Ogata, Y., H. Takada, K. Mizukawa, H. Hirai, S. Iwasa, S. Endo, Y. Mato, M. Saha, K. Okuda, and A. Nakashima. 2009. International Pellet Watch: Global monitoring of persistent organic pollutants (POPs) in coastal waters. 1. Initial phase data on PCBs, DDTs, and HCHs. Marine Pollution Bulletin **58**:1437-1446.

Ognev, S. I. 1935. Mammals of U.S.S.R. and adjacent countries. Volume 3. Carnivora. Glavpushnina NKVT, Moscow, Russia.

Oreskes, N. 2004. The scientifc consensus on climate change. Science **306**:1686.

Orr, J. C., V. J. Fabry, O. Aumont, L. Bopp, S. C. Doney, R. A. Feely, A. Gnanadesikan, N. Gruber, A. Ishida, F. Joos, R. M. Key, K. Lindsay, E. Maier-Reimer, R. Matear, P. Monfray, A. Mouchet, R. G. Najjar, G.-K. Plattner, K. B. Rodgers, C. L. Sabine, J. L. Sarmiento, R. Schlitzer, R. D. Slater, I. J. Totterdell, M.-F. Weirig, Y. Yamanaka, and A. Yool. 2005. Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. Nature **437**:681-686.

Outridge, P., R. Macdonald, F. Wang, G. Stern, and A. Dastoor. 2008. A mass balance inventory of mercury in the Arctic Ocean. Environmental Chemistry **5**:89-111.

Overland, J. E. 2020. Less climatic resilience in the Arctic. Weather and Climate Extremes **30**:100275.

Overland, J. E., E. Hanna, I. Hanssen-Bauer, S. J. Kim, J. E. Walsh, M. Wang, U. S. Bhatt, and R. L. Thoman. 2017. Arctic Report Card 2017.

Peeken, I., S. Primpke, B. Beyer, J. Gütermann, C. Katlein, T. Krumpen, M. Bergmann, L. Hehemann, and G. Gerdts. 2018. Arctic sea ice is an important temporal sink and means of transport for microplastic. Nature Communications **9**:1-12.

Perovich, D., W. Meier, M. Tschudi, S. Farrell, S. Hendricks, S. Gerland, L. Kaleschke, R. Ricker, X. Tian-Kunze, M. Webster, and K. Wood. 2019. Arctic Report Card: Update for

2019 Sea Ice.

Petersen, S., A. Krätschell, N. Augustin, J. Jamieson, J. R. Hein, and M. D. Hannington. 2016. News from the seabed – Geological characteristics and resource potential of deep-sea mineral resources. Marine Policy **70**:175-187.

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

Pitcher, K. W. 1981. Prey of the Steller sea lion, *Eumetopias jubatus*, in the Gulf of Alaska. Fishery Bulletin **79**:467-472.

Pitcher, K. W., V. N. Burkanov, D. G. Calkins, B. J. Le Boeuf, E. G. Mamaev, R. L. Merrick, and G. W. Pendleton. 2001. Spatial and temporal variation in the timing of births of Steller sea lions. Journal of Mammalogy **82**:1047-1053.

Pitcher, K. W., and F. H. Fay. 1982. Feeding by Steller sea lions on harbor seals. The Murrelet:70-71.

Pitcher, K. W., M. J. Rehberg, G. W. Pendleton, K. L. Raum-Suryan, T. S. Gelatt, U. G. Swain, and M. F. Sigler. 2005. Ontogeny of dive performance in pup and juvenile Steller sea lions in Alaska. Canadian Journal of Zoology **83**:1214-1231.

PND. 2021a. Crowley Kotzebue dock preplacement project: Hydroacoustic monitoring report. Anchorage, Alaska.

PND. 2021b. Marine mammal monitoring and mitigation final report for Crowley Kotzebue dock upgrade project. Anchorage, Alaska.

Popper, A. N., and M. C. Hastings. 2009. The effects of anthropogenic sources of sound on fishes. Journal of Fish Biology **75**:455-489.

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.

Popper, A. N., A. D. Hawkins, R. R. Fay, D. A. Mann, S. Bartol, T. J. Carlson, S. Coombs, W. T. Ellison, R. L. Gentry, and M. B. Halvorsen. 2014. Sound exposure guidelines for fishes and sea turtles: a technical report prepared by ANSI-Accredited standards committee S3/SC1 and registered with ANSI. Technical Report ASA S3/SC1. 4 TR-2014, Springer.

Powilleit, M., G. Graf, J. Kleine, R. Riethmüller, K. Stockmann, M. Wetzel, and J. Koop. 2009. Experiments on the survival of six brackish macro-invertebrates from the Baltic Sea after dredged spoil coverage and its implications for the field. Journal of Marine Systems **75**:441-451.

Qi, D., L. Chen, B. Chen, Z. Gao, W. Zhong, Richard A. Feely, Leif G. Anderson, H. Sun, J. Chen, M. Chen, L. Zhan, Y. Zhang, and W.-J. Cai. 2017. Increase in acidifying water in the western Arctic Ocean. Nature Climate Change **7**:195-199.

Quakenbush, L., J. Citta, and J. Crawford. 2011a. Biology of the bearded seal (*Erignathus barbatus*) in Alaska, 1961–2009. Final report from Alaska Dept. of Fish and Game Arctic Marine Mammal Program to the National Marine Fisheries Service, Fairbanks, AK.

Quakenbush, L., J. Citta, and J. Crawford. 2011b. Biology of the ringed seal (*Phoca hispida*) in Alaska, 1960-2010. Final report from Alaska Dept. of Fish and Game Arctic Marine Mammal Program to the National Marine Fisheries Service, Fairbanks, AK.

Quakenbush, L., J. Citta, J. C. George, M. P. Heide-Jørgensen, R. Small, H. Brower, L. Harwood, B. Adams, L. Brower, and G. Tagarook. 2012. Seasonal movements of the Bering-Chukchi-Beaufort stock of bowhead whales: 2006–2011 satellite telemetry results. Report to the International Whaling Commission Scientific Committee SC/64/BRG1.

Quakenbush, L. T., J. A. Crawford, M. A. Nelson, and J. R. Olnes. 2019. Pinniped movements and foraging: village-based satellite tracking and collection of traditional ecological knowledge regarding ringed and bearded seals. Page 131 p. + appendices. Prepared by the Alaska Department of Fish and Game under BOEM Contract M13PC0015 for U.S. Dept. of Interior, Bureau of Ocean Energy Management, Alaska OCS Region, Juneau, AK.

Raum-Suryan, K. L., K. W. Pitcher, D. G. Calkins, J. L. Sease, and T. R. Loughlin. 2002. Dispersal, rookery fidelity, and metapopulation structure of Steller sea lions (*Eumetopias jubatus*) in an increasing and a decreasing population in Alaska. Marine Mammal Science **18**:746-764.

Raum-Suryan, K. L., M. J. Rehberg, G. W. Pendleton, K. W. Pitcher, and T. S. Gelatt. 2004. Development of dispersal, movement patterns, and haul-out use by pup and juvenile Steller sea lions (Eumetopias jubatus) in Alaska. Marine Mammal Science **20**:823-850.

Rea, L. D., J. M. Castellini, L. Correa, B. S. Fadely, and T. M. O'Hara. 2013. Maternal Steller sea lion diets elevate fetal mercury concentrations in an area of population decline. Science of The Total Environment **454-455**:277-282.

Reeves, R., C. Rosa, J. C. George, G. Sheffield, and M. Moore. 2012. Implications of Arctic industrial growth and strategies to mitigate future vessel and fishing gear impacts on bowhead whales. Marine Policy **36**:454-462.

Reeves, R. R. 1998. Distribution, abundance and biology of ringed seals (*Phoca hispida*): an overview. Pages 9-45 *in* M. P. Heide-Jørgensen and C. Lydersen, editors. Ringed Seals in the North Atlantic. NAMMCO Scientific Publications, Volume 1, Tromsø, Norway.

Reine, K., D. Clarke, and C. Dickerson. 2012. Characterization of underwater sounds produced by a backhoe dredge excavating rock and gravel. Page 30 p. U.S. Army Corps of Engineers Dredging Operations and Environmental Research, Vickburg, MS.

Reine, K., D. Clarke, and C. Dickerson. 2014. Characterization of underwater sounds produced by hydraulic and mechanical dredging operations. The Journal of the Acoustical Society of America **135**:3280.

Reine, K. J., and C. Dickerson. 2014. Characterization of underwater sounds produced by a hydraulic cutterhead dredge during maintenance dredging in the Stockton Deepwater Shipping Channel, California. ERDC TN-DOER-E38.

Reinhart, N., S. Ferguson, W. Koski, J. Higdon, B. LeBlanc, O. Tervo, and P. Jepson. 2013. Occurrence of killer whale Orcinus orca rake marks on Eastern Canada-West Greenland bowhead whales Balaena mysticetus. Polar Biology **36**:1133-1146.

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.

Rexford, B. 1997. A native whaler’s view.

Rice, D. W. 1998. Marine mammals of the world: systematics and distribution. Society for Marine Mammology, Lawrence, KS.

Richardson, W. J. 1999. Marine mammal and acoustical monitoring of Western Geophysical's open-water seismic program in the Alaskan Beaufort Sea, 1998. LGL Rep. TA2230-3. Rep. from LGL Ltd., King City, Ontario, and Greeneridge Sciences Inc., Santa Barbara, CA, for Western Geophysical, Houston, TX, and National Marine Fisheries Service, Anchorage, AK, and Silver Spring, MD.

Richardson, W. J. 2008. Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar oil development, Alaskan Beaufort Sea, 1999-2004. LGL Rep. P1004, Final Comprehensive Report from LGL Ltd., Greeneridge Sciences Inc., WEST Inc., and Applied Sociocultural Research for BP Exploration (Alaska) Inc., Anchorage, AK.

Richardson, W. J., C. R. Greene Jr, C. I. Malme, and D. H. Thomson. 1995. Marine mammals and noise. Academic Press, Inc., San Diego, CA.

Riedman, M. 1990. The pinnipeds: Seals, sea lions, and walruses. University of California Press, Berkeley, CA. 439pgs. ISBN 0-520-06498-4.

Rigét, F., A. Bignert, B. Braune, M. Dam, R. Dietz, M. Evans, N. Green, H. Gunnlaugsdóttir, K. S. Hoydal, and J. Kucklick. 2019. Temporal trends of persistent organic pollutants in Arctic marine and freshwater biota. Science of The Total Environment **649**:99-110.

Risch, D., C. W. Clark, P. J. Corkeron, A. Elepfandt, K. M. Kovacs, C. Lydersen, I. Stirling, and S. M. Van Parijs. 2007. Vocalizations of male bearded seals, *Erignathus barbatus*: classification and geographical variation. Animal Behaviour **73**:747-762.

Robinson, S. P., P. D. Theobald, P. A. Lepper, G. Hayman, V. F. Humphrey, L.-S. Wang, and S. Mumford. 2011. Meaasurement of underwater noise arising from marine aggregate operations. Pages 465-468 *in* A. N. Popper and A. Hawkins, editors. The Effects of Noise on Aquatic Life. Springer, New York.

Rochman, C. M. 2015. The complex mixture, fate and toxicity of chemicals associated with plastic debris in the marine environment. Pages 117-140 *in* M. Bergmann, L. Gutow, and M. Klages, editors. Marine Anthropogenic Litter. Springer Open.

Rolland, R. M., K. E. Hunt, S. D. Kraus, and S. K. Wasser. 2005. Assessing reproductive status of right whales (*Eubalaena glacialis*) using fecal hormone metabolites. Gen Comp Endocrinol **142**:308-317.

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**:R614-R622.

Salinger, M. J., J. D. Bell, K. Evans, A. J. Hobday, V. Allain, K. Brander, P. Dexter, D. E. Harrison, A. B. Hollowed, B. Lee, and R. Stefanski. 2013. Climate and oceanic fisheries: recent observations and projections and future needs. Climatic Change **119**:213-221.

Savage, K. 2019. 2018 Alaska Region Marine Mammal Stranding Summary.*in* National Marine Fisheries Service Alaska Region, editor. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Region, Protected Resources Division, Juneau, AK.

Scheffer, V. B. 1958. Seals, sea lions and walruses: a review of the Pinnipedia. Stanford University Press, Palo Alto, CA.

Schoeman, R. P., C. Patterson-Abrolat, and S. Plon. 2020. A global review of vessel collisions with marine animals. Frontiers in Marine Science **7**:25.

Scholin, C. A., F. Gulland, G. J. Doucette, S. Benson, M. Busman, F. P. Chavez, J. Cordaro, R. DeLong, A. De Vogelaere, and J. Harvey. 2000. Mortality of sea lions along the central California coast linked to a toxic diatom bloom. Nature **403**:80-84.

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

Sigler, M. F., S. M. Gende, and D. J. Csepp. 2017. Association of foraging Steller sea lions with persistent prey hot spots in southeast Alaska. Marine Ecology Progress Series **571**:233-

243.

Sigler, M. F., D. J. Tollit, J. J. Vollenweider, J. F. Thedinga, D. J. Csepp, J. N. Womble, M. A. Wong, M. J. Rehberg, and A. W. Trites. 2009. Steller sea lion foraging response to seasonal changes in prey availability. Marine Ecology Progress Series **388**:243-261.

Sills, J. M., C. Reichmuth, B. L. Southall, A. Whiting, and J. Goodwin. 2020. Auditory biology of bearded seals (*Erignathus barbatus*). Polar Biology **43**:1681-1691.

SIMIP Community. 2020. Arctic Sea Ice in CMIP6. Geophysical Research Letters **47**:e2019GL086749.

Simmonds, M. P., and W. J. Eliott. 2009. Climate change and cetaceans: concerns and recent developments. Journal of the Marine Biological Association of the United Kingdom **89**:203-210.

Simpkins, M. A., L. M. Hiruki-Raring, G. Sheffield, J. M. Grebmeier, and J. L. Bengtson. 2003. Habitat selection by ice-associated pinnipeds near St. Lawrence Island, Alaska in March 2001. Polar Biology **26**:577-586.

Sinclair, E. H., and T. K. Zeppelin. 2002. Seasonal and spatial differences in diet in the western stock of Steller sea lions (*Eumetopias jubatus*). Journal of Mammalogy **83**:973-990.

Smith, T. G. 1970. Population dynamics of the ringed seal in the Canadian Eastern Arctic.

Smith, T. G. 1976. Predation of ringed seal pups (*Phoca hispida*) by the Arctic fox (*Alopex agopus*). Canadian Journal of Zoology **54**:1610-1616.

Smith, T. G. 1981. Notes on the bearded seal, *Erignathus barbatus,* in the Canadian Arctic. Canadian Technical Report of Fisheries and Aquatic Sciences **1042**:49 p.

Smith, T. G. 1987. The ringed seal, *Phoca hispida*, of the Canadian western Arctic. 0660124637, Bulletin Fisheries Research Board of Canada, Ottawa, Canada.

Smith, T. G., and F. Armstrong. 1978. Mercury and selenium in ringed and bearded seal tissues from Arctic Canada. Arctic:75-84.

Smith, T. G., M. O. Hammill, and G. Taugbøl. 1991. A review of the developmental, behavioural and physiological adaptations of the ringed seal, *Phoca hispida*, to life in the Arctic winter. Arctic **44**:124-131.

Smith, T. G., and C. Lydersen. 1991. Availability of suitable land-fast ice and predation as factors limiting ringed seal populations, *Phoca hispida*, in Svalbard. Polar Research **10**:585-594.

Smith, T. G., and I. Stirling. 1975. The breeding habitat of the ringed seal (Phoca hispida). The birth lair and associated structures. Canadian Journal of Zoology **53**:1297-1305.

Solé, M., K. Kaifu, T. A. Mooney, S. L. Nedelec, F. Olivier, A. N. Radford, M. Vazzana, M. A. Wale, J. M. Semmens, S. D. Simpson, G. Buscaino, A. D. Hawkins, N. Aguilar de Soto, T. Akamatsu, L. Chauvaud, R. D. Day, Q. Fitzgibbon, R. D. McCauley, and M. André. 2023. Marine invertebrates and noise. Frontiers in Marine Science **10:1129057**.

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**:1-13.

Stafford, K. M. 2018. Increasing detections of killer whales (Orcinus orca), in the Pacific Arctic. Marine Mammal Science.

Stafford, K. M., H. Melling, S. E. Moore, C. L. Berchok, E. K. Braen, A. M. Brewer, and B. M. Kimber. 2022. Marine mammal detections on the Chukchi Plateau 2009–2020. The Journal of the Acoustical Society of America **151**:2521-2529.

Stirling, I., and T. G. Smith. 2004. Implications of warm temperatures and an unusual rain event for the survival of ringed seals on the coast of southeastern Baffin Island. Arctic **57**:59-67.

Stroeve, J., M. M. Holland, W. Meier, T. Scambos, and M. Serreze. 2007. Arctic sea ice decline: Faster than forecast. Geophysical Research Letters **34**.

Stroeve, J., and D. Notz. 2018. Changing state of Arctic sea ice across all seasons. Environmental Research Letters **13**:103001.

Suedel, B. C., A. D. McQueen, J. L. Wilkens, and M. P. Fields. 2019. Evaluating effects of dredging-induced underwater sound to aquatic species: a literature review. U.S. Army Corps of Engineers, Engineer Research and Development Center (ERDC), Dredging Operations and Environmental Research (DOER), Vicksburg, MS.

Suryan, R. M., M. L. Arimitsu, H. A. Coletti, R. R. Hopcroft, M. R. Lindeberg, S. J. Barbeaux, S. D. Batten, W. J. Burt, M. A. Bishop, J. L. Bodkin, R. Brenner, R. W. Campbell, D. A. Cushing, S. L. Danielson, M. W. Dorn, B. Drummond, D. Esler, T. Gelatt, D. H. Hanselman, S. A. Hatch, S. Haught, K. Holderied, K. Iken, D. B. Irons, A. B. Kettle, D. G. Kimmel, B. Konar, K. J. Kuletz, B. J. Laurel, J. M. Maniscalco, C. Matkin, C. A. E. McKinstry, D. H. Monson, J. R. Moran, D. Olsen, W. A. Palsson, W. S. Pegau, J. F. Piatt, L. A. Rogers, N. A. Rojek, A. Schaefer, I. B. Spies, J. M. Straley, S. L. Strom, K. L. Sweeney, M. Szymkowiak, B. P. Weitzman, E. M. Yasumiishi, and S. G. Zador. 2021. Ecosystem response persists after a prolonged marine heatwave. Scientific Reports **11**:6235.

Suydam, R., J. C. George, B. Person, C. Hanns, and G. Sheffield. 2011a. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2010. SC/63/BRG02, International Whaling Commission.

Suydam, R., J. C. George, B. Person, C. Hanns, and G. Sheffield. 2011b. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2010. International Whaling Commission-Scientific Committee, Tromso, Norway.

Suydam, R., J. C. George, B. Person, C. Hanns, R. Stimmelmayr, P. Leslie, and G. Sheffield. 2012. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2011. SC/64/BRG02, IWC Scientific Committee.

Suydam, R., J. C. George, B. Person, C. Hanns, R. Stimmelmayr, P. Leslie, and G. Sheffield. 2014. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2013 IWC Scientific Committee.

Suydam, R., J. C. George, B. Person, C. Hanns, R. Stimmelmayr, L. Pierce, and G. Sheffield. 2013. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2012. SC/65a/BRG19, IWC Scientific Committee.

Suydam, R., J. C. George, B. Person, D. Ramey, C. Hanns, R. Stimmelmayr, L. Pierce, and G. Sheffield. 2015. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2014. SC/66a/BRG06., International Whaling Commission.

Suydam, R., J. C. George, B. Person, D. Ramey, R. Stimmelmayr, T. Sformo, L. Pierce, and G. Sheffield. 2016. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2015 and other aspects of bowhead biology and science. SC/66b/BRG03, International Whaling Commission.

Suydam, R., J. C. George, B. Person, D. Ramey, R. Stimmelmayr, T. Sformo, L. Pierce, and G. Sheffield. 2017. Subsistence harvest of bowhead whales (Balaena mysticetus) by Alaskan Eskimos during 2016. International Whaling Commission.

Sweeney, K., L. Fritz, R. Towell, and T. Gelatt. 2017. Results of Steller sea lion surveys in Alaska, June-July 2017. Memorandum to the Record, December 5, 2017.*in* National Marine Fisheries Service Alaska Fisheries Science Center, editor.

Sweeney, K., R. Towell, and T. Gelatt. 2018. Results of Steller Sea Lion Surveys in Alaska, June-July 2018: Memorandum to The Record. U.S. Dept. of Commerce, NOAA, NMFS, Alaska Fisheries Science Center, Marine Mammal Laboratory, Seattle, WA. December 4, 2018.

Szesciorka, A. R., and K. M. Stafford. 2023. Sea ice directs changes in bowhead whale phenology through the Bering Strait. Movement Ecology **11**:1-13.

Teilmann, J., E. W. Born, and M. Acquarone. 1999. Behaviour of ringed seals tagged with satellite transmitters in the North Water polynya during fast-ice formation. Canadian Journal of Zoology **77**:1934-1946.

Teuten, E. L., J. M. Saquing, D. R. Knappe, M. A. Barlaz, S. Jonsson, A. Björn, S. J. Rowland, R. C. Thompson, T. S. Galloway, and R. Yamashita. 2009. Transport and release of chemicals from plastics to the environment and to wildlife. Philosophical Transactions of the Royal Society B: Biological Sciences **364**:2027-2045.

Thewissen, J. G. M., J. George, C. Rosa, and T. Kishida. 2011. Olfaction and brain size in the bowhead whale (Balaena mysticetus). Marine Mammal Science **27**:282-294.

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.

Todd, V. L. G., I. B. Todd, J. C. Gardiner, E. C. N. Morrin, N. A. MacPherson, N. A. DiMarzio, and F. Thomsen. 2014. A review of impacts of marine dredging activities on marine mammals. ICES Journal of Marine Science **72**:328-340.

Trites, A. W., D. G. Calkins, and A. J. Winship. 2007. Diets of Steller sea lions (*Eumetopias jubatus*) in Southeast Alaska, 1993− 1999. Fishery Bulletin **105**:234-248.

Trites, A. W., B. P. Porter, V. B. Deecke, A. P. Coombs, M. L. Marcotte, and D. A. Rosen. 2006. Insights into the timing of weaning and the attendance patterns of lactating Steller sea lions (*Eumetopias jubatus*) in Alaska during winter, spring, and summer. Aquatic Mammals **32**:85.

Tsujii, K., M. Otsuki, T. Akamatsu, I. Matsuo, K. Amakasu, M. Kitamura, T. Kikuchi, K. Miyashita, and Y. Mitani. 2016. The migration of fin whales into the southern Chukchi Sea as monitored with passive acoustics. ICES Journal of Marine Science **73**:2085-2092.

U.S. Committee on the Marine Transportation System. 2019. A Ten-Year Projection of Maritime Activity in the U.S. Arctic Region, 2020–2030. Page 118 p, Washington, D.C.

USACE. 2012. Environmental assessment and finding of no significant impact for maintenance dredging Nome Harbor entrance channel, Nome, Alaska. Page 70 p. U.S. Army Corps of Engineers, Alaska District, Alaska.

USACE. 2020. Integrated feasibility report and final environmental assessment for the Port of Nome modification feasibility study, Nome, Alaska. Page 305 p. U.S. Army Corps of Engineers, Alaska District, Alaska.

USACE. 2022. Port of Nome Modification 2022 Geotechnical Investigation Arsenic Distribution Evaluation. US Army Corps of Engineers, Anchorage, Alaska.

USACE. 2023. NMFS Biological Assessment Port of Nome Modification Project Nome, Alaska. Page 164 pp. *in* A. D. U.S. Army Corps of Engineers, editor., Anchorage, Alaska.

Van Parijs, S. M. 2003. Aquatic mating in pinnipeds: A review. Aquatic Mammals **29**:214-226.

Van Parijs, S. M., and C. W. Clark. 2006. Long-term mating tactics in an aquatic-mating pinniped, the bearded seal, Erignathus barbatus. Animal Behaviour **72**:1269-1277.

Van Parijs, S. M., K. M. Kovacs, and C. Lydersen. 2001. Spatial and temporal distribution of vocalising male bearded seals: Implications for male mating strategies. Behaviour **138**:905-922.

Van Parijs, S. M., C. Lydersen, and K. M. Kovacs. 2003. Vocalizations and movements suggest alternative mating tactics in male bearded seals. Animal Behaviour **65**:273-283.

Van Parijs, S. M., C. Lydersen, and K. M. Kovacs. 2004. Effects of ice cover on the behavioural patterns of aquatic-mating male bearded seals. Animal Behaviour **68**:89-96.

Vanderlaan, A. S. M., and C. T. Taggart. 2007. Vessel collisions with whales: the probability of lethal injury based on vessel speed. Marine Mammal Science **23**:144-156.

VanWormer, E., J. A. K. Mazet, A. Hall, V. A. Gill, P. L. Boveng, J. M. London, T. Gelatt, B. S. Fadely, M. E. Lander, J. Sterling, V. N. Burkanov, R. R. Ream, P. M. Brock, L. D. Rea, B. R. Smith, A. Jeffers, M. Henstock, M. J. Rehberg, K. A. Burek-Huntington, S. L. Cosby, J. A. Hammond, and T. Goldstein. 2019. Viral emergence in marine mammals in the North Pacific may be linked to Arctic sea ice reduction. Scientific Reports **9**:15569.

Von Duyke, A. L., D. C. Douglas, J. K. Herreman, and J. A. Crawford. 2020. Ringed seal (*Pusa hispida*) seasonal movements, diving, and haul-out behavior in the Beaufort, Chukchi, and Bering Seas (2011–2017). Ecology and evolution **10**:5595-5616.

Vos, J. G., G. D. Bossart, M. Fournier, and T. J. O'Shea. 2003. Toxicology of Marine Mammals. Taylor and Francis, London and New York.

Wade, P. R. 2021. Estimates of abundance and migratory destination for North Pacific humpback whales in both summer feeding areas and winter mating and calving areas. National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Walsh, J. E. 2008. Climate of the Arctic marine environment. Ecological Applications **18**:S3-S22.

Wang, F., and J. E. Overland. 2009. A sea ice free summer Arctic within 30 years? Geophysical Research Letters **36**:L07502.

Wartzok, D., A. N. Popper, J. Gordon, and J. Merrill. 2003. Factors Affecting the Responses of

Marine Mammals to Acoustic Disturbance. Marine Technology Society Journal **37**:6-15.

Wassmann, P., C. M. Duarte, S. Agusti, and M. K. Sejr. 2011. Footprints of climate change in the Arctic marine ecosystem. Global change biology **17**:1235-1249.

Wathne, J. A., T. Haug, and C. Lydersen. 2000. Prey preference and niche overlap of ringed seals (*Phoca hispida*) and harp seals (*P. groenlandica*) in the Barents Sea. Marine Ecology Progress Series **194**:233-239.

Watson, R. T., and D. L. Albritton. 2001. Climate change 2001: Synthesis report: Third assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Webster, M. A., I. G. Rigor, S. V. Nghiem, N. T. Kurtz, S. L. Farrell, D. K. Perovich, and M. Sturm. 2014. Interdecadal changes in snow depth on Arctic sea ice. Journal of Geophysical Research: Oceans **119**:5395-5406.

Werth, A. J., and T. L. Sformo. 2021. Anatomy and function of feeding. Pages 213-223 *in* J. C. George and J. G. M. Thewissen, editors. The bowhead whale: *Balaena mysticetus:* biology and human interactions. Elsevier.

Wilcox, C., G. Heathcote, J. Goldberg, R. Gunn, D. Peel, and B. D. Hardesty. 2015. Understanding the sources and effects of abandoned, lost, and discarded fishing gear on marine turtles in northern Australia. Conservation Biology **29**:198-206.

Willoughby, A. L., M. C. Ferguson, R. Stimmelmayr, J. T. Clarke, and A. A. Brower. 2020. Bowhead whale (*Balaena mysticetus*) and killer whale (*Orcinus orca*) co-occurrence in the U.S. Pacific Arctic, 2009–2018: evidence from bowhead whale carcasses. Polar Biology **43**:1669-1679.

Wilson, S. C., I. Crawford, I. Trukhanova, L. Dmitrieva, and S. J. Goodman. 2020. Estimating risk to ice-breeding pinnipeds from shipping in Arctic and sub-Arctic seas. Marine Policy **111**:103694.

Wilson, S. C., I. Trukhanova, L. Dmitrieva, E. Dolgova, I. Crawford, M. Baimukanov, T. Baimukanov, B. Ismagambetov, M. Pazylbekov, M. Jüssi, and S. J. Goodman. 2017. Assessment of impacts and potential mitigation for icebreaking vessels transiting pupping areas of an ice-breeding seal. Biological Conservation **214**:213-222.

Winter, A., R. J. Foy, and K. Wynne. 2009. Seasonal Differences in Prey Availability Around a Steller Sea Lion Haulout and Rookery in the Gulf of Alaska. Aquatic Mammals **35**:145-162.

Womble, J. N., and S. Conlon. 2010. Observation of Steller Sea Lion (*Eumetopias jubatus*) Predation on a Harbor Seal (Phoca vitulina richardii) in the Glacier Bay Region of

Southeastern Alaska. Aquatic Mammals **36**:129-137.

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

Wright, S. 2021. 2019 Copper River Delta Carcass Surveys, Annual Report. National Marine Fisheries Service, Alaska Region Protected Resources Division, Juneau, AK.

Wursig, B., and C. Clark. 1993. Behavior. Pages 157-199 *in* J. J. Burns, J. J. Montague, and C. J. Cowles, editors. The Bowhead Whale. The Society for Marine Mammalogy, Lawrence, KS.

Würsig, B., E. Dorsey, W. Richardson, and R. Wells. 1989. Feeding, aerial and play behaviour of the bowhead whale, Balaena mysticetus, summering in the Beaufort Sea. Aquatic Mammals **15**:27-37.

Yamamoto, A., M. Kawamiya, A. Ishida, Y. Yamanaka, and S. Watanabe. 2012. Impact of rapid sea-ice reduction in the Arctic Ocean on the rate of ocean acidification. Biogeosciences **9**:2365-2375.

Zarfl, C., and M. Matthies. 2010. Are marine plastic particles transport vectors for organic pollutants to the Arctic? Marine Pollution Bulletin **60**:1810-1814.

Zarnke, R. L., J. T. Saliki, A. P. Macmillan, S. D. Brew, C. E. Dawson, J. M. Ver Hoef, K. J. Frost, and R. J. Small. 2006. Serologic survey for Brucella spp., phocid herpesvirus-1, phocid herpesvirus-2, and phocine distemper virus in harbor seals from Alaska, 1976-1999. Journal of Wildlife Diseases **42**:290-300.

Zhang, J., J. Du, S. Zhang, S. Yang, and Q. Xu. 2022. The effects of acidification on arsenic concentration and speciation in offshore shallow water system. Marine Pollution Bulletin **181**:113930.

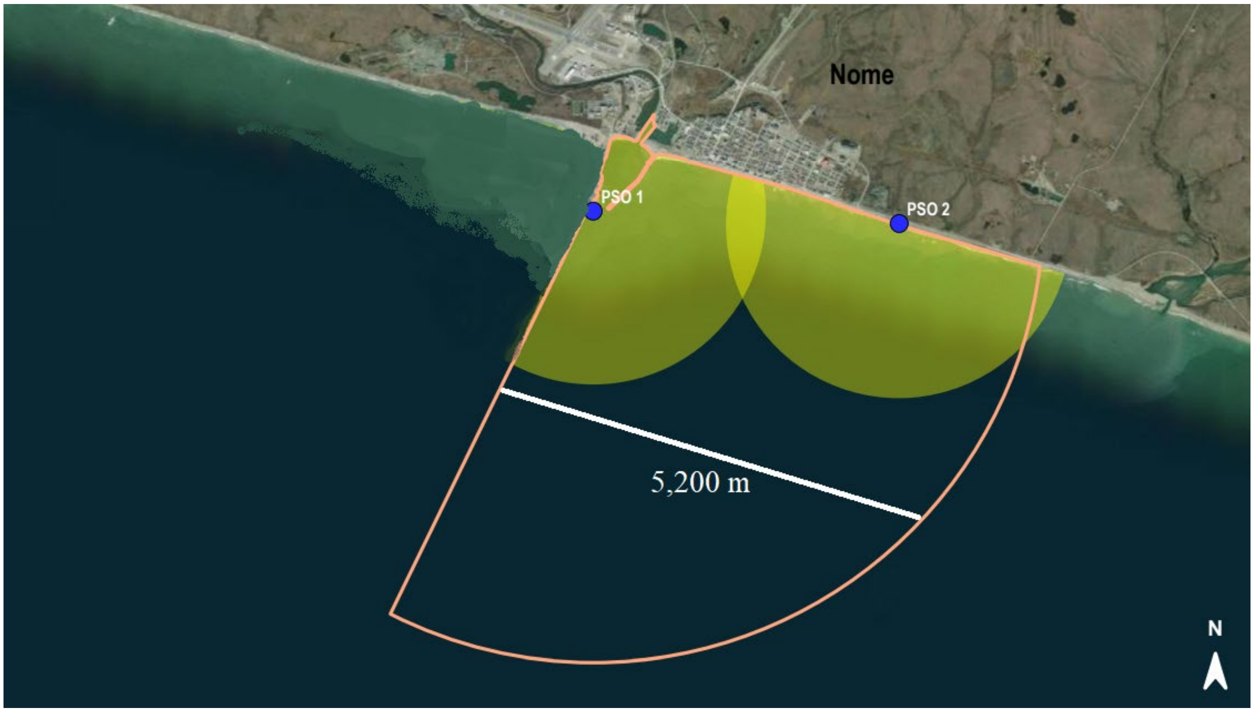

Figure 4. Level B harassment zone for 20” sheet piles is outlined in orange (zone has a radius of 5,200 m). The yellow shaded area is the area that a PSO can reliable observe marine mammals. Zone location is not fixed; it would change as the causeway is built out.

Figure 5. Level B harassment zone for 36” fender (pipe) piles is outlined in purple (zone has a radius of 21,600 m). The yellow shaded area is the area that a PSO can reliable observe marine mammals. Zone location is not fixed; it would change as the causeway is built out.