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

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

Crowley Fuels Dock Expansion and Upgrade
(POA-2018-00199)
NMFS Consultation Number: AKRO-2020-00125

Action Agencies: National Marine Fisheries Service, Office of Protected Resources - Permits and Conservation Division (PR1), US Army Corps of Engineers (USACE)

Affected Species and Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species	Is the Action Likely to Adversely Affect Critical Habitat	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Ringed Seal, Arctic Subspecies (*Phoca hispida hispida*)	Threatened	Yes	NA	No	NA
Bearded Seal, Beringia DPS (*Erignathus barbatus nauticus*)	Threatened	Yes	NA	No	NA

Consultation Conducted By: National Marine Fisheries Service, Alaska Region

Issued By:

for James W. Balsiger, Ph.D.
Administrator, Alaska Region

Date: June 10, 2020

https://doi.org/10.25923/3rdk-jn76

Accessibility of this Document

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

TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

TERMS AND ABBREVIATIONS

µPa	Micro Pascal
BIA	Biologically Important Area
BSAI	Bering Sea/Aleutian Island
CI	Confidence Interval
CPUE	Catch Per Unit Effort
CWA	Clean Water Act
dB	Decibels
DDT	Dichloro-Diphenyltrichloroethane
DPS	Distinct Population Segment
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ft	Feet
Hz	Hertz
IHA	Incidental Harassment Authorization
IPCC	Intergovernmental Panel on Climate Change
ITS	Incidental Take Statement
IWC	International Whaling Commission
km	Kilometers
km^2	Square Kilometers
L	Liters
Mi	Miles
MMPA	Marine Mammal Protection Act
NMFS	National Marine Fisheries Service
NPDES	National Pollution Discharge Elimination System
OC	organochlorine
opinion	Biological Opinion
PAH	Polycyclic Aromatic Hydrocarbons
PAM	Passive Acoustic Monitoring
PBDE	Polybrominated Diphenyl
PBR	Potential Biological Removal
PCB	Polychlorinated Biphenyls
PCE	Primary Constituent Element
PR1	Office of Protected Resources- Permits and Conservation Division
PSO	Protected Species Observer
PTS	Permanent Threshold Shift
RMS	Root Mean Square
RPA	Reasonable Prudent Alternative
TTS	Temporary Threshold Shift
UME	Unusual Mortality Event
USFWS	United States Fish and Wildlife Service

1. INTRODUCTION

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

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

For the actions described in this document, the action agencies are the United States Army Corps of Engineers (Corps) which proposes to permit the renovation of Crowley Fuels' dock in Kotzebue, AK, and the NMFS Office of Protected Resources, Permits and Conservation Division (hereafter referred to as the Permits Division or PR1). The Permits Division plans to issue an incidental harassment authorization (IHA) pursuant to section 101(a)(5)(D) of the Marine Mammal Protection Act of 1972, as amended (MMPA) (16 U.S.C. 1361 et seq.) for harassment of marine mammals incidental to the proposed activities (83 FR 40234). When issued, the IHA will be valid from June 1, 2020 through September 2020, and will authorize the incidental harassment of two ESA-listed pinniped species, the threatened Beringia Distinct Population Segment (DPS) bearded seal (*Erignathus barbatus nauticus*) and threatened Arctic ringed sea (*Phoca hispida hispida*). The Corps determined that there will be no effect to the endangered bowhead whale (*Balanea mysticetus*), the endangered fin whale (*Balaneoptera physalus*), the threatened Mexico DPS humpback whale (*Megaptera novaeangliae*), or the endangered Western North Pacific DPS humpback whale (*Megaptera novaeangliae*).

The consulting agency for this proposal is NMFS's Alaska Region (AKR). This document represents our biological opinion (opinion) on the proposed actions and their effects on endangered and threatened species.

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

1.1 Background

This opinion considers the effects of repairs and renovations to the Crowley Fuels Dock in Kotzebue, AK as well as the issuance of an IHA to take marine mammals by harassment under the MMPA incidental to that work. These actions have the potential to affect threatened Arctic subspecies ringed seals (*Phoca hispida hispida*) and threatened Beringia DPS bearded seals (*Erignathus barbatus nauticus*). Critical habitat has not been designated for either species.

This biological opinion is based on information provided by PND Engineers (non-federal designee), Revised Incidental Harassment Authorization Application; February 2020, Environmental Baseline, Biological Resource Assessment, and Essential Fish Habitat Report (BA); February 2020, Proposed Incidental Harassment Authorization (85 FR 23766), updated project proposals, email and telephone conversations between NMFS Alaska Region and NMFS PR1 staff; and other sources of information. A complete record of this consultation is on file at NMFS's Anchorage, Alaska office.

1.2 Consultation History

January 15, 2020. NMFS AKR received an email from PR1 that they had received a request for an Incidental Harassment Authorization (IHA) from Crowley Fuels, LLC. PR1sent the IHA application and a document titled Environmental Baseline, Biological Resource Assessment, and Essential Fish Habitat Report (BA).

February 5, 2020. NMFS received a letter from the U.S. Army Corps of Engineers requesting consultation with us on the project and assigning PND Engineers, Inc. as the non-federal designee.

February 12, 2020. NMFS received the draft Marine Mammal Mitigation and Monitoring Plan (4MP) from PND Engineers.

February 27, 2020. A revised 4MP was received.

March 3, 2020. NMFS AKR and PR1 had a teleconference to discuss the project.

March 4, 2020. AKR sent an email to PND Engineers requesting clarification on the 4MP.

March 6, 2020. A letter was sent to Alaska Department of Fish and Game requesting any relevant information they might have on the project.

March 19, 2020. A peer review meeting with representatives from the native communities, NOAA's Marine Mammal Lab, and the Marine Mammal Commission was held remotely.

April 6, 2020. Permits Division sent out responses they received from the PND Engineers to questions they had about various aspects of the project.

April 15, 2020. The Permits Division indicated they had all the information they needed from the applicant.

April 28, 2020. Comments were received from the Peer Review Committee.

April 29, 2020. The draft Federal Notice regarding the IHA application was published.

May 15, 2020. A letter of initiation was received from PR1 and the consultation was initiated.

From January 30, 2020 to June 3, 2020 there was extensive coordination (emails, phone calls) between PR1, PND Engineers, and AKR.

2. DESCRIPTION OF THE PROPOSED ACTION

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 (50 CFR § 402.02). The purpose of this project is to expand, repair, and upgrade the Crowley Fuels dock in Kotzebue, AK. The proposed action is expected to occur from June to September 2020. However, there is the possibility that with the uncertainties and delays that may occur as a result of the COVID-19 pandemic, work will not be finished in this time frame and that the project will not be completed until the summer of 2021. Work effort is expected to be 11-hour days, with one additional work hour reserved for safety briefings and other non-impactful tasks.

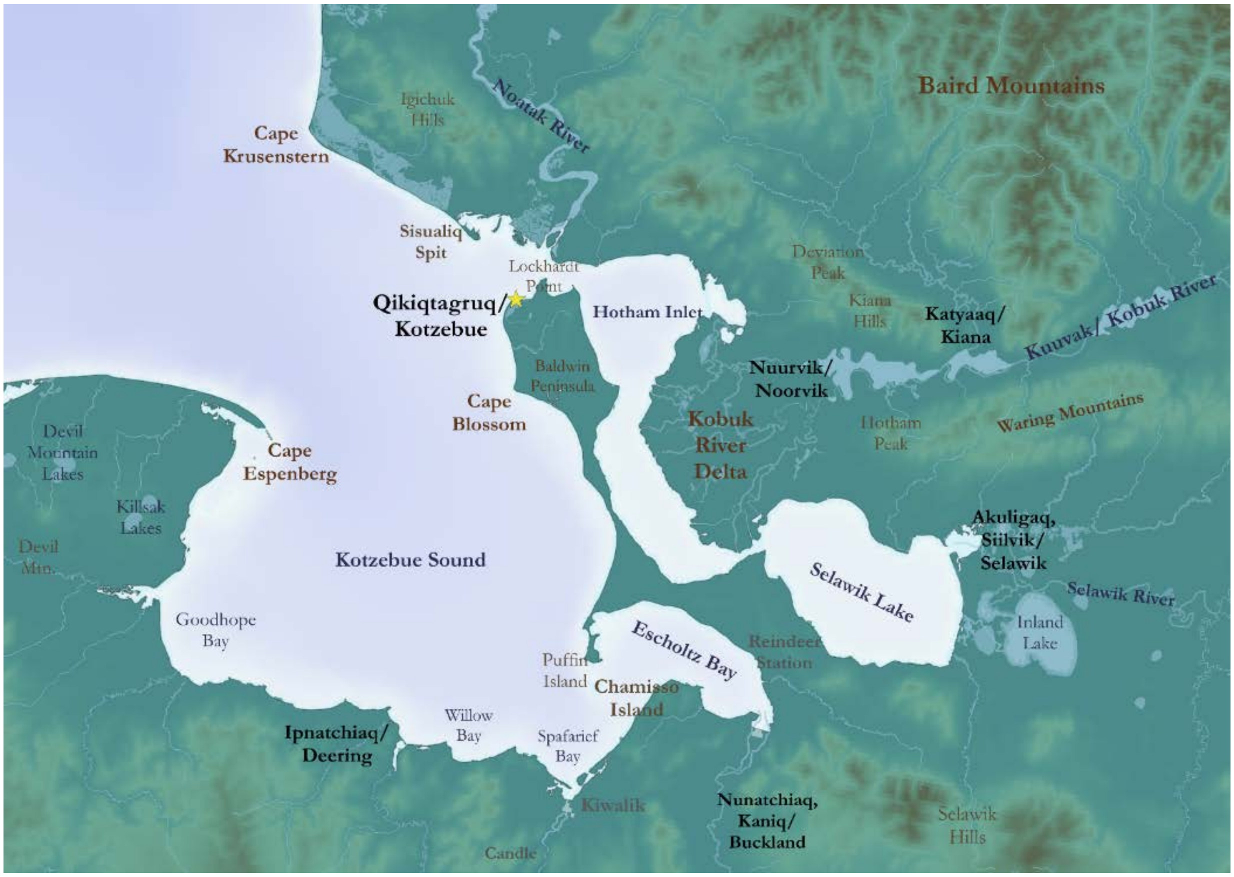

Figure 1. Vicinity map for the Crowley Fuels Dock Expansion Project. The project will occur at approximately the location of the yellow star.

2.2 Proposed Activities

The purpose of the project is to upgrade the existing Crowley sheet pile bulkhead for vessel-based fuel and cargo distribution in Kotzebue, AK (Figure 1). The Crowley Kotzebue Fuel Dock provides berthing for Crowley's bulk fueling operations and also provides essential access for community barges, cargo-loading, subsistence harvest, and other community events. Over the past 15 years, the dock has been repaired multiple times. Several areas of localized erosion are present along the length of the wall that pose a risk to stability of the bulkhead. The bulkhead must be replaced to restore the dock serviceability and prevent further damage to the facility and impacts to operations.

The new dock will be constructed with an OPEN CELL SHEET PILE® (OCSP) structure, a bulkhead utilizing flat-web sheet piles, fabricated connector wyes, and anchor piles (Figure 2). One cell will be constructed at a time. This type of bulkhead is a flexible steel sheet pile membrane supported by soil contact with the embedded steel pile tail walls. No demolition is planned for this project, so the new sheet pile bulkhead will provide additional protection for the existing fuel header system and associated piping. A new potable water service and 120/208-volt power service will be provided near the existing marine header. New sheet pile cells will be installed seaward of the existing dock, so no demolition of existing dock face will be required.

2.2.1 Temporary Template Piles

Temporary piles for bulkhead template structures will be installed to aid with sheet pile cell construction and will be removed after the permanent sheet piles or support piles have been installed. Temporary template piles will be either steel pipe piles (18-inch or smaller) or H-piles (14-inch or smaller). Up to 170 temporary template piles will be needed for this project. Quantities noted in Table 1 are for either pipe piles or H-piles, not cumulative.

Temporary template piles will be driven with a vibratory hammer. All piles are expected to be installed using land-based crane and a vibratory hammer. It is anticipated that the largest size vibratory hammer used for the project will be an APE 200-6 (eccentric moment of 6,600 inch-pounds) or comparable vibratory hammer from another manufacturer such as ICE or HPSI. It is estimated that not more than ten template piles will be installed per day. Temporary piles will be removed following bulkhead construction using vibratory extraction methods. Means and methods for extraction will be similar to temporary pile installation.

2.2.1 Sheet Piles

The new sheet pile bulkhead dock consists of fourteen OCSP cells. The sheet piles will be installed in pairs using the vibratory hammer on land. After all the piles for a sheet pile cell have been installed, clean gravel fill will be placed within the cell. This process will continue sequentially until all of the sheet pile cells are installed and backfilled.

2.2.3 Anchor Piles

Fourteen-inch H-pile anchor piles with welded connectors to secure the structure will be installed at the end of each sheet pile tailwall using a vibratory hammer on land.

2.2.4 Fill Placement

The bulkhead will be filled with clean gravel materials after each cell is closed. Fill will be transported from an off-site quarry to the project site using loaders, dump trucks, and dozers within the project footprint as needed. It will be placed within the cells from the shore (or occasionally a barge) using the same equipment and will be finished using roller compactors and graders.

2.2.5 Bollard Piles

Twenty-four-inch pipe piles will be installed at nine locations along the dock face to support mooring bollards. Bollard piles will be driven into completed, compacted cells using a vibratory hammer on land. No in water sound is anticipated from the installation of these piles.

2.2.6 Utilities

A new potable water service and 120/208-volt power service will be provided near the south end of the new dock. The potable water service will consist of a buried two-inch diameter HDPE line. The power service will be routed in a buried conduit from the nearby Crowley Dock Office.

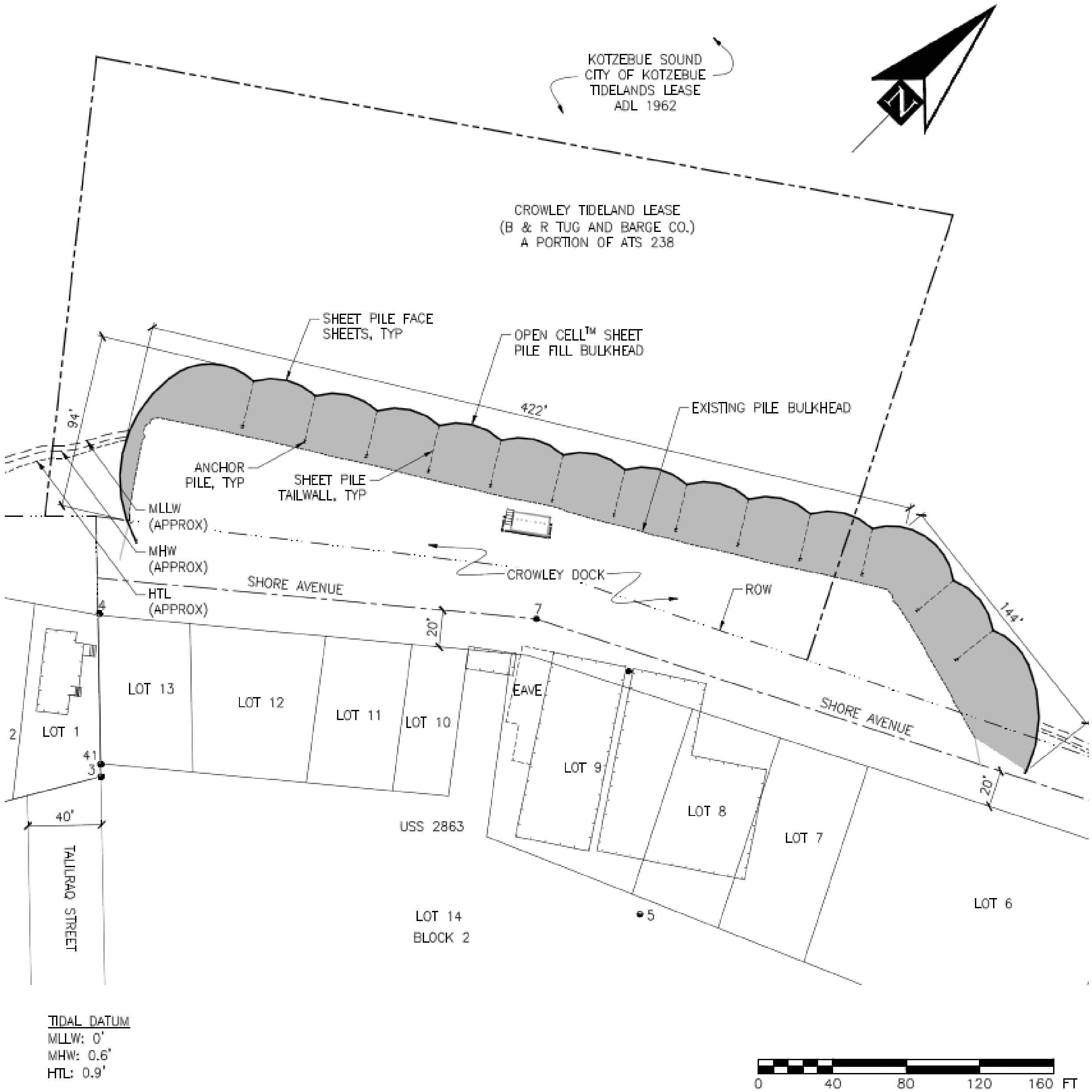

Figure 2. Project overview.

Table 1. Materials and impacts summary.

	Construction Method	Project Total	Below HTL (EL =0.9)	Below MHW (EL=0.6)	Below MLLW (EL=0)	Hours Per Day	Days Effort
Footprint (acre)	(all)	0.66	0.60	0.60	0.60	N/A	N/A
Temporary template piles (Pipe piles 18")	Vibratory Installation	170	170	170	170	1.7	17
Temporary template piles (Pipe piles 18")	Vibratory Removal	170	170	170	170	1.7	17
(*Alternate*) temp. template piles (H-piles 14")	Vibratory Installation	(170)	(170)	(170)	(170)	1.7	17
+(*Alternate*) temp. template piles (H-piles 14")	Vibratory Removal	(170)	(170)	(170)	(170)	1.7	17
Anchor piles (14" HP14x89 or similar)	Vibratory Installation	15	13	13	13	1.7	2
Sheet piles (20" PS31 or similar)	Vibratory Installation	650	645	645	645	1.7	44
Gravel Fill (CY)	Conventional Equipment	18,700	12,400	12,100	11,500	11	30
Upland Bollard piles (Pipe piles 24")	Vibratory Installation	9	9	9	9	1.5	1

2.3 Mitigation Measures Proposed by NMFS's IHA Stipulations

Standard operating procedures and mitigation measures will be implemented during the proposed action. Mitigation measures are used to avoid or reduce potential impacts. The standard operating procedures and mitigation measures that are applicable to the proposed action are provided below.

2.3.1 Best Management Practices

The following best management practices (BMPs) will be incorporated by the applicant in order to minimize impacts to waters of the U.S.:

- New sheet piles will be installed seaward of the existing dock, containing it and removing the need for demolition or disturbance of the existing dock. Enclosing the existing dock will also provide more dockside space for safe handling of bulk fuel deliveries.
- A silt curtain will be deployed during pile driving operations to prevent turbidity and negative impacts to water quality. This measure will also prevent fish from entering the injury isopleth for fish during pile driving. Both results will reduce the potential for impacts to prey species.
- Fill placed in the tidelands will be clean gravel fill. Fill will contain relatively few fines to reduce impacts to turbidity and/or sedimentation. Fill will be placed in completed sheet pile cells, providing containment and removing the need for a silt curtain.
- The dock will be maintained in a manner that does not introduce any pollutants or debris into the harbor or cause a migration barrier for fish.
- Fuels, lubricants, and other hazardous substances will not be stored below the ordinary high-water mark. All chemicals and petroleum products will be properly stored to prevent spills. Petroleum products, cement, chemicals, or other deleterious materials will not be allowed to enter surface waters.
- Oil booms will be readily available for containment should any releases occur.
- The contractor will check for leaks regularly on any equipment, hoses, and fuel storage that occur at the project site.
- Noise levels will be minimized by the use of appropriately sized piles. The use of vibratory pile driving methods will also reduce sound levels entering the water during construction and reduce the impacts to marine mammals, fish, and seabirds. Properly sized equipment will be used to drive piles.
- To minimize impacts from vessels interactions with marine mammals, the crews aboard vessels delivering materials will follow NMFS's marine mammal viewing guidelines and regulations as practicable. (https://alaskafisheries.noaa.gov/protectedresources/mmv/guide.htm).

2.3.2 General Mitigation Measures

Marine mammal monitoring must be conducted in accordance with the Marine Mammal Monitoring Plan, dated February 2020, the mitigation measures in the IHA and the mitigation measures presented here.

1. Three land-based PSOs will be present during all pile driving/removal activities to monitor the Level B harassment zone and the shutdown zone. All three PSOs will observe as much of the Level B harassment zone as possible (Figure 3). PSO locations are as follows:
    a. at or near the site of pile driving;
    b. along the shore, north of the project site;

   c. along the shore, south of the project site.

2. Placement of PSOs on the shoreline around the project site will allow PSOs to observe marine mammals within the Level B harassment zones. Due to the large Level B harassment zone (Figure 4), PSOs will not be able to effectively observe the entire zone. Therefore, Level B harassment exposures will be recorded and extrapolated based upon the number of observed takes and the percentage of the Level B harassment zone that was not visible. PSOs will have an unobstructed view of all water within the shutdown zone.
3. Prior to the start of all pile driving activities, the construction supervisor will meet with the crew and the PSOs to explain responsibilities, communication procedures, marine mammal monitoring protocol, and operational procedures.

Figure 3. Placement and observable zone (2000 m) for PSOs.

4. Each day prior to the start of pile driving, the lead PSO will conduct a radio check with the construction foreman, POC, or superintendent, and the other PSOs to confirm activities, and zones to be monitored that day. The construction foreman and lead PSO will maintain communication throughout the day so the PSOs may be alerted to any change in the planned construction activities and zones to be monitored.

5. Crowley will establish a 10-meter shutdown zone for all in-water construction activities. The purpose of a shutdown zone is to define an area within which shutdown of the activity would occur upon sighting of a marine mammal (or in anticipation of an animal entering the defined area) for avoidance of physical injury.

2.3.4 Protected Species Observer Requirements

6. PSOs must be independent (i.e., not construction personnel) and have no other assigned tasks during monitoring periods;
7. A lead observer or monitoring coordinator must be designated. The lead observer must have prior experience working as a marine mammal observer during construction;
8. Other PSOs may substitute education (degree in biological science or related field) or training for experience. PSOs may also substitute Alaska native traditional knowledge for experience. (NMFS recognizes that PSOs with traditional knowledge may also have prior experience, and therefore be eligible to serve as the lead PSO.);
9. Crowley must submit PSO CVs for approval by NMFS prior to the onset of pile driving.
10. Protected Species Observers (PSOs) must:
    a. be in good physical condition and be able to withstand harsh weather conditions for an extended period of time;
    b. have vision correctable to 20-20;
    c. have the ability to effectively communicate orally, by radio and in person, with project personnel;
    d. have prior experience collecting field observations and recording field data accurately according to project protocols;
    e. be able to complete data entry forms accurately;
    f. be able to identify Alaskan marine mammals to species;
    g. be able to record marine mammal behavior; and
    h. have technical writing skills sufficient to create understandable reports of observations
11. PSOs will complete on-the-job or project specific training prior to deployment to the project site. The training will include:
    a. field identification of marine mammals and marine mammal behavior;
    b. ecological information on Alaska's marine mammals and specifics on the ecology and management concerns of those marine mammals;
    c. ESA and MMPA regulations;
    d. mitigation measures outlined in the IHA and this biological opinion;

e. proper equipment use;

f. methodologies in marine mammal observation and data recording and proper reporting protocols; and

g. PSO roles and responsibilities.

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

13. PSOs will have the ability and authority to order appropriate mitigation response to avoid takes of marine mammals.

14. The PSOs will have the following to perform their duties:

a. tools which enable them to accurately determine the position of a marine mammal (e.g. range finder, compass);

b. two-way radio communication, or equivalent, with onsite project manager;

c. appropriate personal protective equipment;

d. watch or chronometer;

e. binoculars (7x50 or higher magnification) with built-in rangefinder or reticles (rangefinder may be provided separately);

f. a copy of all mitigation measures printed on waterproof paper and bound; and

g. observation record forms printed on waterproof paper, or weatherproof electronic device allowing for required PSO data entry.

15. PSOs will have no other primary duties beyond watching for, acting on, recording observations of, and reporting events related to, marine mammals.

2.3.5 Pile Driving Noise Mitigation Measures

16. Prior to commencing pile driving activities, PSOs will scan waters within the shutdown zone and confirm no marine mammals are observed to be present within the shutdown zone for 30 minutes prior to initiation of the in-water activity. If one or more marine mammals are observed within the shutdown zone, pile driving will not begin until the marine mammals exit the shutdown zone of their own accord, and the zone has remained clear of marine mammals for 30 minutes immediately prior to pile driving activities. The PSOs will continuously monitor the shutdown zone during pile driving operations for the presence of marine mammals.

17. In-water activities will take place during daylight conditions and with a Beaufort Sea State of 4 or less, with adequate visibility to see the entire shutdown zone and adjacent waters to effectively shut down activities prior to a marine mammal entering a shutdown zone.

18. If visibility degrades to where the PSOs can no longer ensure the detectability of all marine mammals that are likely to enter the shutdown zone during pile driving then all in-water work that may affect marine mammals will cease until the entire shutdown zone is visible and completely and effectively monitored, and the PSOs have indicated that the zone has remained devoid of marine mammals for 30 minutes prior to additional activity.

19. The PSO will order pile driving activities to immediately cease if one or more marine mammals appears likely to enter, or occur within, the shutdown zone. The PSO on duty will immediately call or radio the operators and initiate a shutdown of pile driving activities. If direct communication with the operators is not practical, the construction crew point of contact will relay the shutdown order to the equipment operators.

20. Following shutdown of pile driving activities for less than 30 minutes due to the presence of marine mammals in the shutdown zone, pile driving may commence when the PSO provides assurance that listed marine mammals were observed exiting the shutdown zone or have not been seen in the shutdown zone for 15 minutes.

21. Following a lapse of pile driving activities of more than 30 minutes, the PSO will authorize resumption of activities only if no listed marine mammals have been present in the shutdown zone for at least 30 minutes immediately prior to resumption of operations.

22. If a marine mammal is observed within a shutdown zone during pile driving activities, or is otherwise harassed, harmed, injured, or disturbed, PSOs will report that occurrence to NMFS (Marilyn.Myers@noaa.gov, and Greg.Balogh@noaa.gov). If a crew member sees incidences of harassment, harm, injury, or disturbance of marine mammals, they may contact NMFS directly, or report the incident to a PSO who has been designated as the point of contact between crew members and NMFS. The PSO will then notify NMFS.

23. Monitoring will be conducted 30 minutes after pile driving/removal and drilling activities.

24. PSOs shall record all incidents of marine mammal occurrence, regardless of distance from activity, and shall document any behavioral reactions in concert with distance from piles being driven or removed. Pile driving activities include the time to install or remove a single pile or series of piles, as long as the time elapsed between uses of the pile driving or drilling equipment is no more than thirty minutes.

2.3.6 Data Collection and Reporting

25. PSOs will record observations on data forms or into electronic data sheets. Electronic copies of marine mammal observations will be submitted to NMFS in a digital spreadsheet format at the end of the project.

26. PSOs will use NMFS-approved Observation Records. Observation Records will be used to record the following:

a. Date and time that monitored activity begins or ends;

b. Construction activities occurring during each observation period;

c. Weather parameters (e.g., percent cover, visibility);

d. Water conditions (e.g., sea state, tide state);

e. Species, numbers, and, if possible, sex and age class of marine mammals;

f. Description of any observable marine mammal behavior patterns, including bearing and direction of travel and distance from pile driving activity;

g. Distance from pile driving activities to marine mammals and distance from the marine mammals to the observation point;

h. Locations of all marine mammal observations;

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

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

k. An extrapolation of the estimated takes by Level B harassment based on the number of observed exposures within the Level B harassment zone and the percentage of the Level B harassment zone that was not visible; and

l. Other human activity in the area.

27. In the event that personnel involved in the construction activities discover an injured or dead marine mammal, the IHA-holder shall report the incident to the Office of Protected Resources (OPR) (301-427-8401), NMFS and to the Alaska Statewide 24-Hour Stranding Hotline (877-925-7773) as soon as feasible. If the death or injury was clearly caused by an authorized activity, the IHA-holder must immediately cease the specified activities until NMFS is able to review the circumstances of the incident and determine what, if any, additional measures are appropriate to ensure compliance with the terms of the IHA. The IHA-holder must not resume their activities until notified by NMFS. A report about the injured or deceased animal must include the following information:

a. Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable);

b. Species identification (if known) or description of the animal(s) involved;

c. Condition of the animal(s) (including carcass condition if the animal is dead);

d. Observed behaviors of the animal(s), if alive;

e. If available, photographs or video footage of the animal(s); and

f. General circumstances under which the animal was discovered.

28. A draft marine mammal monitoring report will be submitted to NMFS within 90 days after the completion of pile driving and removal activities. The report will include an overall description of work completed, a narrative regarding marine mammal sightings, and associated PSO data sheets. Specifically, the report must include:

a. Summaries of monitoring effort including total hours, observation rate by species and marine mammal distribution through the study period, accounting for sea state and other factors affecting visibility and detectability of marine mammals.

b. Analyses of the effects of various factors that may have influenced detectability of marine mammals (e.g., sea state, number of observers, fog/glare, and other factors as determined by the PSOs).

c. Species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), group sizes, and ice cover.

d. Marine mammal observation data (i.e., PSO data as specified in Item 26) with a digital record of observation data provided in digital spreadsheet format that can be queried.

e. Summary of implemented mitigation measures (i.e., shutdowns and delays)

f. Number of marine mammals during periods with and without project activities (and other variables that could affect detectability), such as: (i) initial sighting distances versus project activity at the time of sighting; (ii) closest point of approach versus project activity; (iii) observed behaviors and types of movements versus project activity; (iv) numbers of sightings/individuals seen versus project activity; (v) and numbers of animals detected in the Shutdown Zone.

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

h. Compare the number of takes (i.e., instances of exposure) authorized in the ITS with those observed during project operations.

29. If no comments are received from NMFS within 30 days, the draft report will constitute the final report. If comments are received, a final report addressing NMFS comments must be submitted within 30 days after receipt of comments.

2.4 Action Area

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

The action area for this biological opinion includes (1) the area in the immediate vicinity of the

Crowley Fuels Dock where the construction activities will occur and (2) the maximum ensonified harassment area as a result of the vibratory pile driving (Figure 4). No transit routes are included because Crowley Fuels Dock is the primary dock in the local region with regularly scheduled shipments of goods and fuel for the local area. The transport of materials for the project will not increase vessel traffic over that which is typical for the area.

Within this area, the sound source with the greatest propagation distance is anticipated to be associated with pile driving using a vibratory hammer which can produce sounds at or above the Level B harassment zone, 120 dB re 1µPa (rms), out to a distance of 5,168 m from the sound source (see Section 6.3.1.2 for explanation of calculations). The 120 dB isopleth was chosen because that is where we anticipate pile driving noise levels would approach ambient noise levels (i.e., the point where no measurable effect from the project would occur). While project noise may propagate beyond the 120 dB isopleth, we do not anticipate that marine mammals would respond in a biologically significant manner at these low levels and great distance from the source.

Table 2. All pile installation and removal is by a vibratory hammer. Removal sound levels are assumed to be equal to installation for the temporary piles (From PND 2020).

	Literature Source	**Predicted Source Level (SPL RMS) @ 10 m**	**Peak Source Level SPL RMS) @ 10 m**	**Shutdown Zone**	**Predicted Disturbance Isopleth (m) Level B**
Template Piles (18" pipe piles) [a]	Pritchard Lake Pumping Plant, 2014[b]	158.0	174.0	10	3,414.5
(*Alternate*) temp. template piles (H-piles 14")	URS Corporation, 2007	158.8	173.8	10	3,871.5
Anchor Piles 14" H piles	URS Corporation, 2007	158.8	173.8	10	3,871.5
Sheet piles (20" PS31 or similar)	PND 2016	160.7	171.5	10	5,168.1

[a] As noted in the *Section 2.2.1*, Crowley has not determined the exact type of template pile they will use. We conservatively conducted the impact analysis with the maximum potential pile sizes that they may choose to use.
[b] Source level is the average of three 18-inch pipe piles installed at Pritchard Lake Pumping Plant. Data originally provided by Illingworth and Rodkin, Inc. and accessed in Caltrans, 2015.

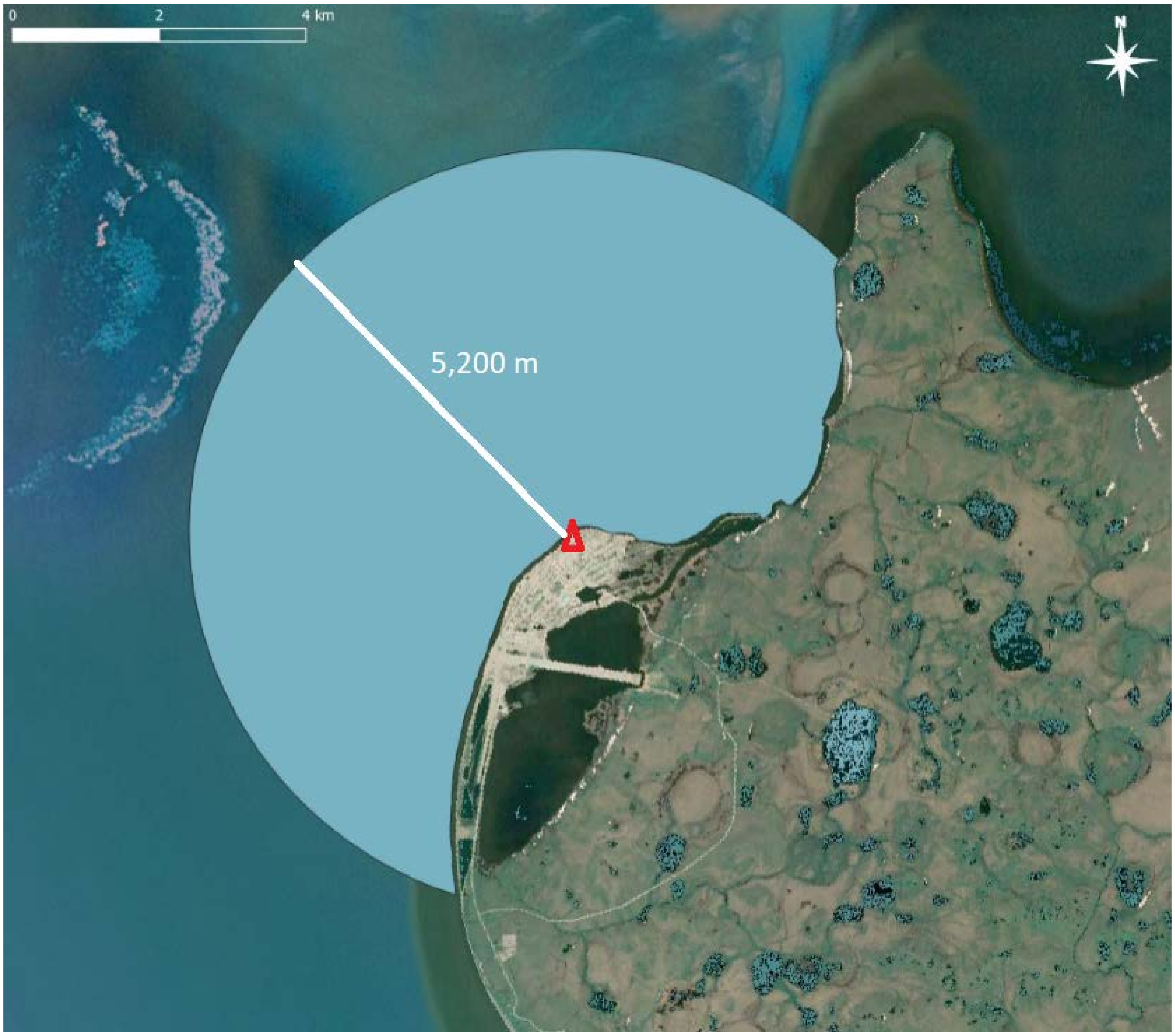

Figure 4. Action area for Crowley Fuels Dock Expansion Project. Zone extends to 5,200 m, rounded up from the calculated 5,168 m Level B harassment zone. Red triangle marks location of project.

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, we consider the likely impacts to a species' survival as well as likely impacts to its recovery. Further, it is possible that in certain, exceptional circumstances, injury to recovery alone may result in a jeopardy biological opinion (51 FR 19926, 19934; June 3, 1986).

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

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).

We use the following approach to determine whether the proposed action described in Section 2 above is likely to jeopardize listed species:

- Identify those aspects (or stressors) of the proposed action that are likely to have direct or indirect effects on listed species or critical habitat. As part of this step, we identify the action area – the spatial and temporal extent of these direct and indirect effects.
- Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action. This section describes the current status of each listed species and its critical habitat relative to the conditions needed for recovery. We determine the rangewide status of critical habitat by examining the condition of its PBFs - which were identified when the critical habitat was designated. Species are discussed in Section 4 of this opinion.
- Describe the environmental baseline including: past and present impacts of Federal, state, or private actions and other human activities in the action area; anticipated impacts of proposed Federal projects that have already undergone formal or early Section 7 consultation, and the impacts of state or private actions that are contemporaneous with the consultation in process. The environmental baseline is discussed in Section 5 of this opinion.
- Analyze the effects of the proposed actions. Identify the listed species that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our exposure analyses). In this step of our analyses, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to stressors and the populations or subpopulations those individuals represent. NMFS also evaluates the proposed action's effects on critical habitat features. The effects of the action are described in Section 6 of this opinion with the exposure analysis described in Section 6.2 of this opinion.
- Once we identify which listed species are likely to be exposed to an action's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how those listed species are likely to respond given their exposure (these represent our response analyses). Response analysis is considered in Section 6.3 of this opinion.

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

4. RANGEWIDE STATUS OF THE SPECIES AND CRITICAL HABITAT

Two species of marine mammals listed under the ESA under NMFS's jurisdiction may occur in the action area. No critical habitat has been designated for these species (Table 3).

Table 3. Listing status and critical habitat designation for marine mammal species considered in this opinion.

Species	Status	Listing	Critical Habitat
Phoca hispida hispida (Arctic Ringed Seal)	Threatened	NMFS 2012, 77 FR 76706	Not designated
Erignathus barbatus nauticus (Beringia DPS Bearded Seal)	Threatened	NMFS 2012, 77 FR 76739	Not designated

4.1 Climate Change

One potential threat common to bearded and ringed seals is global climate change. In accordance with NMFS guidance on analyzing the effects of climate change (Sobeck 2016), NMFS assumes that climate conditions will be similar to the status quo throughout the length of the effects of this short duration project.

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

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

Continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century (Watson and Albritton 2001). Climate change is projected to have substantial effects on individuals, populations, species, and the structure and function of marine, coastal, and terrestrial ecosystems in the foreseeable future (Houghton 2001, McCarthy 2001, Parry 2007). Climate change would result in increases in atmospheric temperatures, changes in sea surface temperatures, increased ocean acidity, changes in patterns of precipitation, and changes in sea level (Stocker et al. 2013).

According to NOAA's National Center for Environmental Information (NOAA NCEI 2019), the global annual temperature has increased at an average rate of 0.07°C (0.13°F) per decade since 1880 and over twice that rate (+0.18°C / +0.32°F) since 1981. In the 43 years since 1977, global land and ocean temperatures have been above the 20th century average every year. The five warmest years in the 1880–2019 record have all occurred since 2015, with nine of the ten warmest years occurring since 2005 (the tenth warmest year was in 1998). The year 2019 was the second warmest year in the 140-year record for both land and ocean temperatures, surpassed only by 2016 which was 0.04°C (0.07°F) hotter, and followed closely by 2015 which was only 0.02°C (0.04°F) cooler than 2019.

In Alaska, 2019 was the hottest year on record. The year 2019 also saw the highest ocean heat content (OHC) for the upper 2000 meters in the 70-year record; the five highest OHC have all occurred in the last five years (2015–19), while the last ten years (2010–19) have the 10 highest OHC on record (NOAA NCEI 2019).

4.2 Status of Listed Species Likely to be Adversely Affected by the Action

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

This section consists of narratives for each of the threatened species that may be adversely affected by the proposed action. In each narrative, we present a summary of information on the population structure and distribution of each species to provide a foundation for the exposure analyses that appear later in this opinion. Then we summarize information on the threats to the species and the species' status given those threats to provide points of reference for the jeopardy determinations we make later in this opinion. That is, we rely on a species' status and trend to determine whether or not an action's direct or indirect effects are likely to increase the species' probability of becoming extinct.

More detailed background information on the status of these species can be found in a number of published documents including stock assessment reports for Alaska marine mammals (Muto et al. 2019) and the comprehensive status review reports completed in 2010 for bearded and ringed seals (Cameron et al. 2010, Kelly et al. 2010).

4.2.1 Arctic Ringed Seal

4.2.1.1 Status and Population Structure

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

Ringed seal population surveys in Alaska have used various methods and assumptions, incompletely covered their habitats and range, and were conducted more than a decade ago; therefore, current and comprehensive abundance estimates or trends for the Alaska stock are not available. Bengtson et al. (2005) conducted aerial surveys in the Alaska Chukchi Sea during May and June of 1999 and 2000. While the surveys were focused on the coastal zone within 37 km (23 mi) of shore, additional survey lines were flown up to 185 km (115 mi) offshore. Population estimates were derived from observed densities corrected for availability bias using a haul-out model from six tagged seals. Ringed seal abundance estimates for the entire survey area were 252,488 (standard error = 47,204) in 1999 and 208,857 (standard error = 25,502) in 2000.

Using the most recent survey estimates from surveys by Bengtson et al. (2005) and Frost et al. (2004) in the late 1990s and 2000, Kelly et al. (2010) estimated the total population in the Alaska Chukchi and Beaufort seas to be at least 300,000 ringed seals. This estimate is likely an underestimate since the Beaufort Sea surveys were limited to within 40 km from shore.

Although a reliable population estimate for the entire Alaska stock is not available, research programs have developed survey methods that have been used to determine abundance estimates for part of the stock (Muto et al. 2019). In spring of 2012 and 2013, U.S. and Russian researchers conducted image-based aerial abundance and distribution surveys over the entire Bering Sea and Sea of Okhotsk (Moreland et al. 2013). Conn et al. (2014), using a very limited subsample of the data collected from the U.S. portion of the Bering Sea in 2012, calculated an abundance estimate of 171,418 (95% confidence interval 141,588-201,090). The estimate does not account for availability bias and did not include ringed seals in the shore fast ice zone which was surveyed using different design. Thus, the number of ringed seals in the U.S. portion the Bering Sea is likely much higher, perhaps by a factor of two or more (Muto et al. 2019).

4.2.1.2 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 kilometers to forage along ice edges or in highly productive open-water areas (Harwood and Stirling 1992, Freitas et al. 2008, Kelly et al. 2010, Harwood et al. 2015).

With the onset of freeze-up in the fall, ringed seal movements become increasingly restricted. Ringed seals that have summered in the Beaufort Sea are thought to move west and south with the advancing ice pack, with many seals dispersing throughout the Chukchi and Bering seas while some remain in the Beaufort Sea (Frost and Lowry 1984, Crawford et al. 2012, Harwood et al. 2012). Some adult ringed seals return to the same small home ranges they occupied during the previous winter (Kelly et al. 2010).

During a cooperative project, the Native Village of Kotzebue, the University of Alaska, and the Alaska Department of Fish and Game, tagged 37 ringed seals near Kotzebue from 2007–2009. This study showed differences in movements between age-classes, especially in winter. Adult seals tended to stay in the Chukchi Sea and northern Bering Sea during winter, while the subadults moved to the southern extent of the ice to winter along the ice edge (Crawford et al. 2012).

4.1.2.3 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 (Frost 1985, Kelly 1988a), and therefore are in the action area. With the onset of the fall freeze, ringed seal movements become increasingly restricted and seals will either move west and south with the advancing ice pack with many seals dispersing throughout the Chukchi and Bering Seas, or remain in the Beaufort Sea (Frost and Lowry 1984, Crawford et al. 2012, Harwood et al. 2012).

Ringed seals were found and captured in June in Kotzebue Sound in 2014 and 2017, but not after 2017 (Quakenbush et al. 2019). The results of tagging studies by Quakenbush et al. (2019) showed that in the summer, the tagged ringed seals traveled north to areas favorable for feeding such as the Hanna shoals. All 16 tagged, mostly adult, ringed seals exhibited strong, seasonal, latitudinal patterns in movements throughout the year, using high-latitudes during the open-water season (July–November) and lower latitudes, near or south of the Bering Strait, when ice was present (December–June).

Cooperative satellite tagging efforts between local hunting experts in Kotzebue and biologists have found that ringed seals are common in Kotzebue Sound during spring before the more aggressive spotted seals arrive, driving them from the area until they return to the Sound in fall (Huntington et al. 2016). Recently mapped ranges show ringed seals in Kotzebue Sound from February until June and returning in October and November (Audubon, 2010).

The NAB (2016) has identified the project area, and more broadly, Kotzebue Sound, as an important use area for ringed seal feeding. Additionally, they identified a high-density feeding area south of the project area, along the southern end of Baldwin Peninsula **(**Figure 5). Annual distribution of ice seals in Kotzebue Sound in early spring and summer is highly variable year to year depending on the retreat and expansion of the sea ice in the spring and fall.

4.2.1.4 Threats

Threats that have been identified for the ringed seal include the effects resulting from climate change (loss of ice, ocean acidification); overutilization from commercial, subsistence or illegal harvest; pollution and contaminants; oil and gas exploration, development and production; and commercial fisheries and associated by catch. More details on these threats are provided in the ***5. Environmental Baseline*** and in the Status Review for the species (Kelley et al. 2010). ***https://www.fisheries.noaa.gov/resource/document/status-review-ringed-seal-phoca-hispida-2010***

Figure 5. Ringed seal important use areas in Kotzebue Sound (NAB 2016).

4.2.1.5 Reproduction and Growth

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. Seal mothers continue to forage throughout lactation and move young pups between lairs within their network of lairs. The pups spend time learning diving skills, using multiple breathing holes, and nursing and resting in lairs (Smith and Lydersen 1991, Lydersen and Hammill 1993). After a 5 to 8-week lactation period, pups are weaned (Lydersen and Hammill 1993, Lydersen and Kovacs 1999).

Mating is thought to take place under the ice in the vicinity of birth lairs while mature females are still lactating (Kelly et al. 2010). Ringed seals undergo an annual molt (shedding and regrowth of hair and skin) that occurs between mid-May to mid-July, during which time they spend many hours hauled out on the ice (Reeves 1998). The relatively long periods of time that ringed seals spend out of the water during the molt have been ascribed to the need to maintain elevated skin temperatures during new hair growth (Feltz and Fay 1966). Figure 6 summarizes the approximate annual timing of Arctic ringed seal reproduction and molting (Kelly et al. 2010).

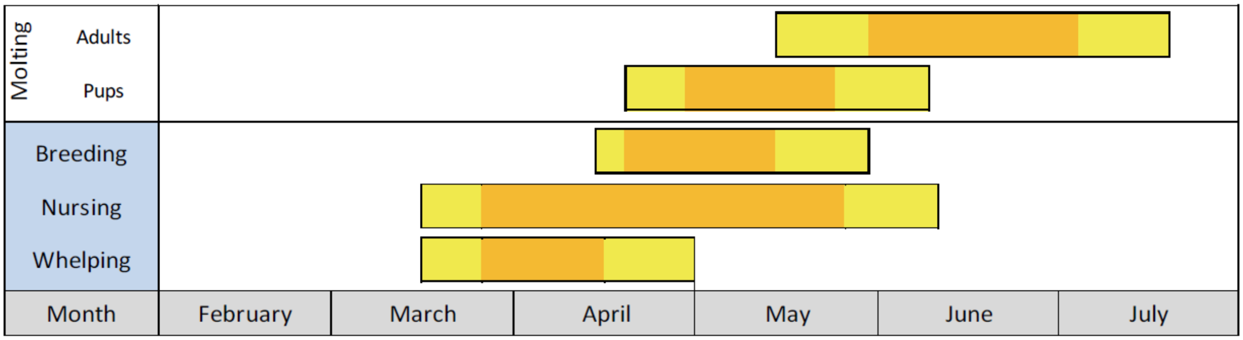

Figure 6. Approximate annual timing of Arctic ringed seal reproduction and molting. Yellow bars indicate the "normal" range over which each event is reported to occur and orange bars indicate the "peak" timing of each event (Kelly et al. 2010).

4.2.1.6 Feeding and Prey

Ringed seals feed year-round, but forage most intensively during the open-water period and early freeze-up, when they spend 90 percent or more of their time in the water (Kelly et al. 2010). Many studies of the diet of Arctic ringed seal have been conducted and although there is considerable variation in the diet regionally, several patterns emerge. Most ringed seal prey is small, and preferred prey tends to be schooling species that form dense aggregations. Fish of the cod family tend to dominate the diet from late autumn through early spring in many areas (Kovacs 2007). Quakenbush et al. (2019) found that Barrow Canyon and the intercontinental shelf break in the northern Chukchi Sea were important foraging areas for ringed seals.

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

4.2.1.7 Hearing, Vocalizations, and Other Sensory Capabilities

Ringed seals produce underwater vocalizations which range from approximately 0.1 to 1.0 kHz (Jones et al. 2014) in association with territorial and mating behaviors. Underwater audiograms for ringed seals indicate that their hearing is most sensitive at 49 dB re 1 µPa (12.8 kHz) in water, and -12 dB re 20 µPa (4.5 kHz) in air (Sills et al. 2015). Underwater audiograms for phocids suggest that they have very little hearing sensitivity below 1 kHz, though they can hear underwater sounds at frequencies up to 60 kHz and make calls between 90 Hz and 16 kHz

(Richardson et al. 1995). NMFS defines the functional hearing range for phocids (seals) as 50 Hz to 86 kHz (NMFS 2016b).

Sills et al. (2015) suggested that because ringed seal hearing is sensitive for a greater frequency range than their vocalizations, their hearing is likely not only used for detection of the vocalizations conspecifics (Sills et al. 2015), but may also be important in locating breathing holes and the ice edge, detection of predators, locating prey, and orienteering (Elsner et al. 1989, Wartzok et al. 1992, Miksis-Olds and Madden 2014). Sills et al. (2015) further reported that ringed seal hearing appears to be resistant to masking across a range of frequencies, as indicated by their enhanced ability to detect signals from background noise.

Most phocid seals spend greater than 80% of their time submerged in the water (Gordon et al. 2003); consequently, they will be exposed to sounds from pile driving that occurs in their vicinity. Phocids have good low-frequency hearing; thus, it is expected that they will be more susceptible to masking of biologically significant signals by low frequency sounds (Gordon et al. 2003). Masking of biologically important sounds by anthropogenic noise could be considered a temporary loss of hearing acuity. Brief, small-scale masking episodes likely have few long-term consequences for individual ringed seals.

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).
Additional information on ringed seals can be found at:
https://www.fisheries.noaa.gov/resource/document/status-review-ringed-seal-phoca-hispida-2010

4.2.2 Beringia DPS Bearded Seal

4.2.2.1 Status and Population Structure

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

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

Although 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 aerial abundance and distribution surveys over the entire Bering Sea and Sea of Okhotsk (Moreland et al. 2013). The data from these image-based surveys are still being analyzed, but for the U.S. portion of the Bering Sea Boveng et al. (2017) reported model-averaged abundance estimates of 170,000 and 125,000 bearded seals in 2012 and 2013, respectively. These results reflect use of an estimate of availability (haulout correction factor) based on data from previously deployed satellite tags. The authors suggested that the difference in seal density between years may reflect differences in the numbers of bearded seals using Russian versus U.S. waters between years, and they noted that if this was the case, the eventual development of comprehensive estimates of abundance for bearded seals in the Bering Sea that incorporate data in Russian waters may show less difference between years.

4.2.2.2 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 (Burns and Harbo 1972, Burns and Frost 1979, Burns 1981, Smith and Hammill 1981, Fedoseev 1984, Nelson et al. 1984).

Suitable ice conditions and water depths occur in limited areas of the Chukchi Sea for bearded seals, and over much broader areas in the Bering Sea (Burns 1981). During winter, the central and northern parts of the Bering Sea shelf, where heavier pack ice occurs, have the highest densities of adult bearded seals (Heptner et al. 1976, Burns and Frost 1979, Burns 1981, Nelson et al. 1984, Cameron et al. 2018), possibly reflecting the favorable ice conditions there.

It is thought that in the fall and winter most bearded seals move south with the advancing ice edge through Bering Strait into the Bering Sea where they spend the winter, and in the spring and early summer, as the sea ice melts, many of these seals move north through the Bering Strait into the Chukchi and Beaufort Seas (Burns 1967, Burns and Frost 1979, Burns 1981, Cameron and Boveng 2007, Cameron and Boveng 2009, Cameron et al. 2018). However, bearded seal vocalizations have been recorded year-round in the Chukchi and Beaufort Seas (MacIntyre et al. 2013, MacIntyre et al. 2015), indicating some unknown proportion of the population occurs there over winter.

The summer distribution is quite broad, with seals rarely hauled out on land (Burns 1967, Heptner et al. 1976, Burns 1981, Nelson et al. 1984). However some seals, mostly juveniles, have been observed hauled out on land along lagoons and rivers in some areas of Alaska, such as in Norton Bay (Huntington 2000) and near Wainwright (Nelson 1982) and on sandy islands near Barrow (Cameron et al. 2010).

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. Pup and yearling bearded seals were able to remain in open water without hauling out for several weeks at a time. Foraging areas identified for bearded seals included Barrow Canyon, Kotzebue Sound, Bering Strait, Norton Sound, northeast and southeast of St. Lawrence Island, and along the 100 m isobath of the Bering Shelf. Bearded seals used ice and land to haul out during the open water season, however, their haul-out durations were twice as long on ice. During years that sea ice did not advance into the central Bering Sea (2017 and 2018), bearded seals restricted their winter movements to the northern and eastern Bering Sea.

4.2.2.3 Occurrence in the Action Area

Aerial surveys of ringed and bearded seals in the Eastern Chukchi Sea in May and June reported relatively few bearded seals within inner Kotzebue Sound, as bearded seals typically congregate on offshore ice rather than nearshore. Bearded seal densities just outside of Cape Krusenstern were 0.001 – 0.7 bearded seals per seals per km^2 (Bengtson et al. 2005). In 1976 aerial surveys of bearded seals in the Bering Sea, densities ranged between 0.006 and 0.782 seals per seals per km^2. Bearded seals typically occur in groups of one to two individuals with occasional larger groupings in denser areas (Braham et al. 1984).

Many bearded seals spend the winter months in the Bering Sea and then move north through the Bering Strait between late April and June. They then continue into the Chukchi Sea where they spend the summer months along the fragmented and drifting ice pack. Bearded seals have been observed in the Chukchi Sea year-round when sea ice coverage was greater than 50%. 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). Bearded seals are most common in Kotzebue Sound during spring, before the more aggressive spotted seals arrive and drive them from the area until the juveniles return to the sound in fall (Huntington et al. 2016). Juvenile (birth-year) seals tend to remain in Kotzebue Sound near Sisualiq Spit and the mouth of the Noatak River through the summer Figure 7 (NAB, 2016)

Recently mapped ranges show adult bearded seals in Kotzebue Sound from March until June and returning in October and November (Audubon, 2010). The NAB (2016) has identified the project area, and more broadly, Kotzebue Sound, as a bearded seal important use area for feeding and migration. Additionally, they identified a high-density feeding area north of the project area, along Sisualiq Spit (Figure 7). Annual distribution of ice seals in Kotzebue Sound in early spring and summer is highly variable year to year depending on the retreat and expansion of the sea ice in the spring and fall.

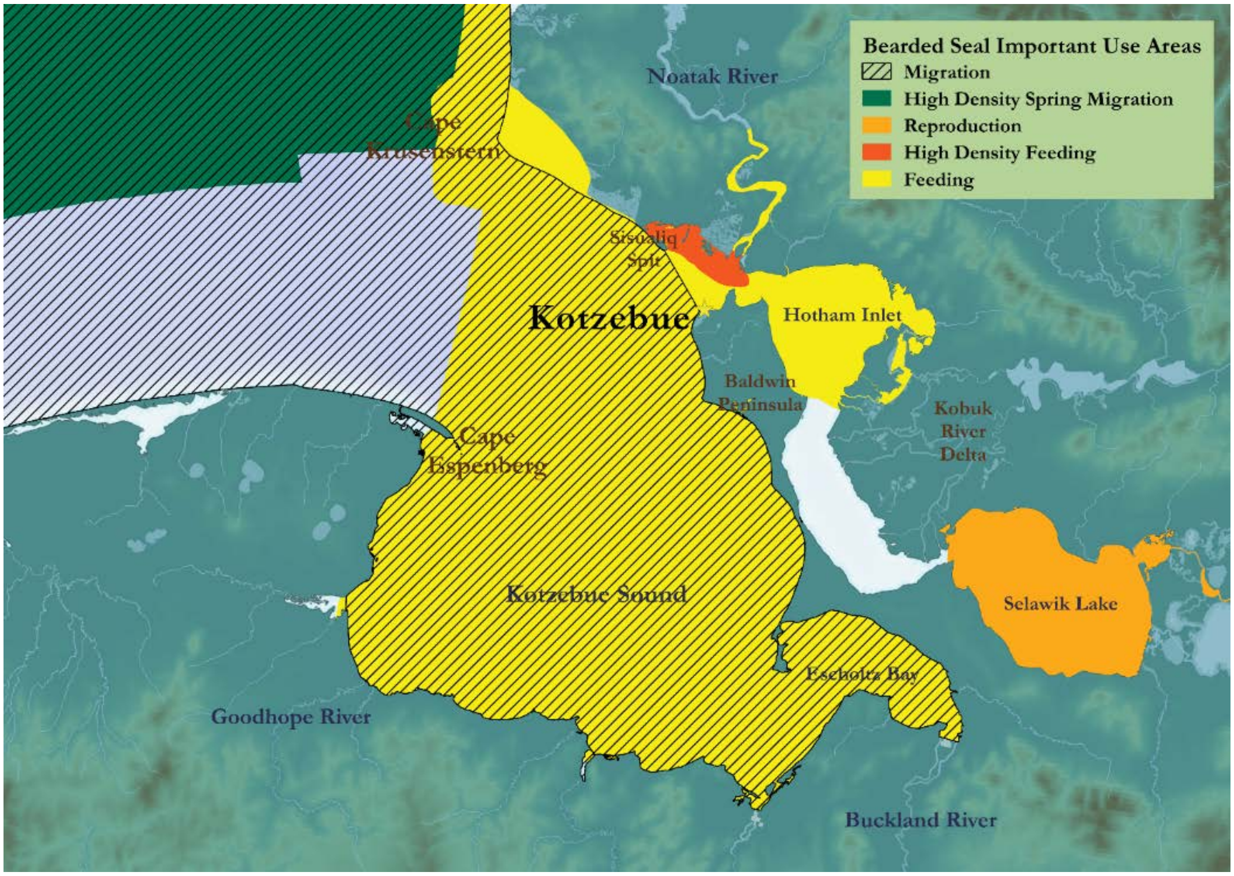

Figure 7. Bearded seal important use areas in Kotzebue Sound (NAB 2016)

4.2.2.4 Feeding and Prey

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

Quakenbush et al. (2011b) reported that fish consumption appeared to increase between the 1970s and 2000s for Alaska bearded seals sampled in the Bering and Chukchi Seas, although the difference was not statistically significant. Bearded seals also commonly consumed invertebrates, which were found in 95% of the stomachs sampled. In the 2000s, sculpin, cod, and flatfish were the dominant fish taxa consumed (Quakenbush et al. 2011b). The majority of invertebrate prey items identified in the 2000s were mysids, isopods, amphipods, and decapods. Decapods were the most dominant class of invertebrates, and were strongly correlated with the occurrence of shrimp and somewhat correlated with the occurrence of crab. Mollusks were also common prey, occurring in more than half of the stomachs examined.

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

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

4.2.2.5 Reproduction and growth

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

In the spring, adult males are suspected to spend a majority of their time in the water vocalizing and defending territories, though a few observations suggest they are not entirely aquatic and may haul out near females with or without pups (Krylov et al. 1964, Burns 1967, Fedoseev 1971, Finley and Renaud 1980).

The social dynamics of mating in bearded seals are not well known because detailed observations of social interactions are rare, especially underwater where copulations are believed to occur. Theories regarding their mating system have centered around serial monogamy and promiscuity, and more specifically on the nature of competition among breeding males to attract and gain access to females (Stirling et al. 1983, Budelsky 1992, Stirling and Thomas 2003).

Whichever mating system is favored, sexual selection driven by female choice is predicted to have strongly influenced the evolution of male displays, and possibly size dimorphism, and caused the distinct geographical vocal repertoires recorded from male bearded seals in the Arctic (Stirling et al. 1983, Atkinson 1997, Risch et al. 2007). Bearded seals are solitary throughout most of the year except for the breeding season.

4.2.2.6 Hearing and Vocalization

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

Most phocid seals spend greater than 80% of their time submerged in the water (Gordon et al. 2003); consequently, they will be exposed to sounds from pile driving that occurs in their vicinity. Phocids have good low-frequency hearing; thus, it is expected that they will be more susceptible to masking of biologically significant signals by low frequency sounds, such as those from vibratory pile driving in which the frequencies produced are typically in a range of 20-40 Hz.

Underwater audiograms for ice seals suggest that they have very little hearing sensitivity below 1 kHz; but hear underwater sounds at frequencies up to 60 kHz; and make calls between 90 Hz and 16 kHz (Richardson et al. 1995). NMFS defines the functional hearing range for phocids as 50 Hz to 86 kHz (NMFS 2018).

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 area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process. 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).

5.1 Stressors for Species in the Action Area

The following discussion summarizes the principal natural and anthropogenic stressors that affect ringed and bearded seals. Bearded and ringed seals are considered together in this section because the stressors have a similar effect on both species:

- Climate change
- Biotoxins, disease, and predation
- Targeted hunts
- Anthropogenic noise
- Oil and gas development
- Arctic projects, research
- Pollutants and contaminants
- Vessel and fisheries interactions

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

- "Alaska Marine Mammal Stock Assessments, 201" (Muto et al. 2019), Available online at https://www.fisheries.noaa.gov/resource/%7Bpath_utils%7D/alaska-marine-mammal-stock-assessments-2016
- "Status Review of the Ringed Seal (*Phoca hispida*)" (Kelly et al. 2010), Available online at http://www.nmfs.noaa.gov/pr/species/Status%20Reviews/Ringed%20seal%202012_.pdf"
- "Status Review of the Bearded Seal (*Erignathus barbatus*)" https://repository.library.noaa.gov/view/noaa/3761

5.1.1 Climate Change

Because of its effects on Arctic ice, ocean temperature, and ocean pH, climate change is one of the primary threats to ringed and bearded seals and is exerting the greatest change to their habitat. 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 an accelerated rate (Figure 8). The linear rate of sea ice decline for September has been 12.9% relative to the 1981-2010 average (NSIDC 2019) and approximately three-quarters of summer Arctic sea ice volume has been lost since the 1980s (IPCC 2013). Since 1979, the areal proportion of thick ice at least 5 years old has declined by approximately 90% (IPCC 2019). In 1985, the oldest ice comprised 16% of the ice pack whereas in March of 2018, old ice only constituted 0.9% of the ice pack (Perovich et al. 2018).

The National Snow and Ice Data Center (NSIDC) reported that the Arctic sea ice extent for March (month of greatest ice extent) 2018 averaged 14.30 million km^2, the second lowest in the 1979 to 2018 satellite record (Table 4). This was 1.13 million km^2 below the 1981 to 2010 average and 30,000 km^2 above the record low March extent in 2017. Sea ice extent at the end of March 2018 was far below average in the Bering Sea, as it had been in the prior several months (NSIDC 2018). The sea ice extent in March of 2019 was marginally better, it tied for the seventh lowest on the record (NSIDC 2019); however, in September of 2019, the minimum sea ice extent tied with the second lowest minimum (NSIDC 2019). In 2020, Arctic sea ice reached its annual maximum extent on March 5. The 2020 maximum sea ice extent is the eleventh lowest in the 42-year satellite record, but the highest since 2013. At the end of the March, 2020, ice extent was particularly low in the Bering Sea after a rapid retreat during the second half of the month (http://nsidc.org/arcticseaicenews/2020/03/). Sea ice conditions in 2020 will have a large influence on the number of seals that may be present in the action area during proposed action. If sea ice retreats early as it has in the last two years, we would expect fewer seals in the Kotzebue Sound area in June through September.

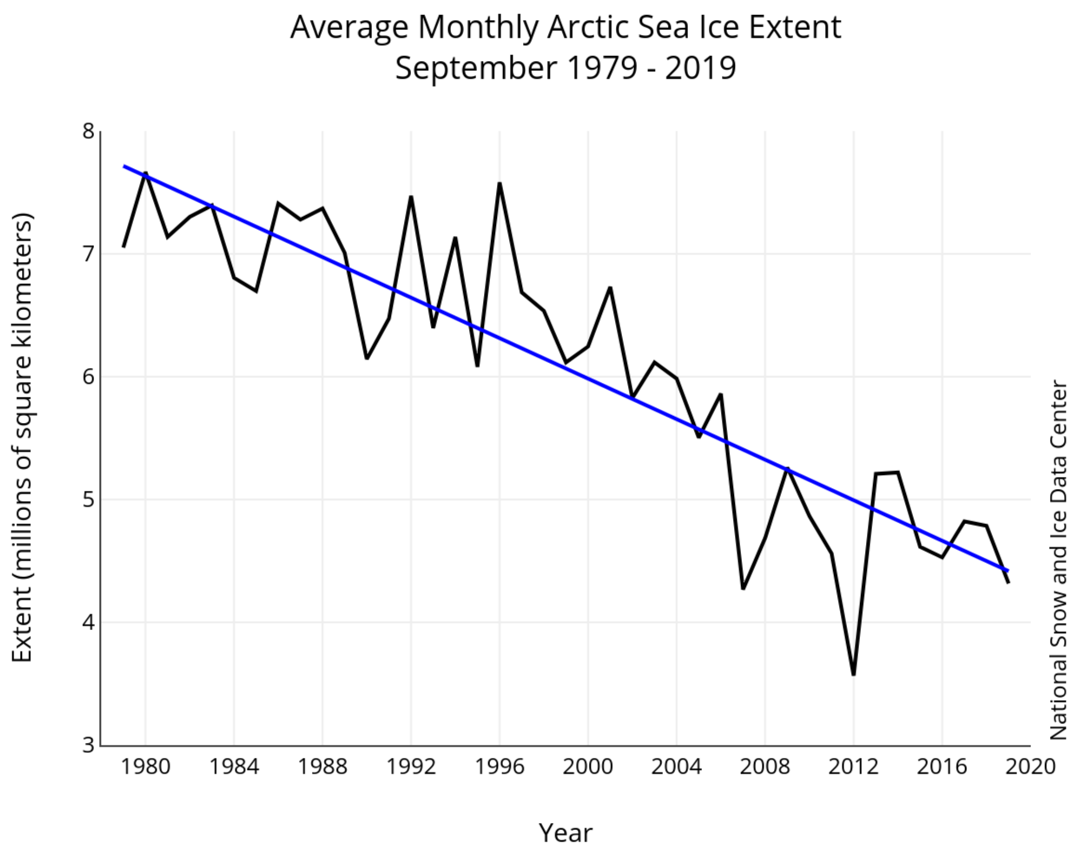

Figure 8. Average monthly Arctic sea Ice Trend for September (lowest annual extent). http://nsidc.org/arcticseaicenews/2019/10/

Quakenbush et al. (2019) identified changes in the behavior of tagged ringed and bearded seals with decreasing sea ice. Ringed seals were found and captured in June in Kotzebue Sound in 2014 and 2017, but not after 2017 when sea ice was at particularly low levels. During years that sea ice did not advance into the central Bering Sea (2017 and 2018), bearded seals restricted their winter movements to the northern and eastern Bering Sea. In addition, in 2018-2019, when the April sea ice in the Bering Sea was a small fraction of its historical extent, a NOAA cruise found no ribbon or spotted seals in their historically preferred breeding areas (NOAA Fisheries 2019).

Rank	Year	In millions of square kilometers	In millions of square miles	Date
1	2017	14.41	5.56	March 7
2	2018	14.48	5.59	March 17
3	2016 2015	14.51 14.52	5.60 5.61	March 23 February 25
5	2011 2006	14.67 14.68	5.66 5.67	March 9 March 12
7	2007 2019	14.77 14.78	5.70 5.71	March 12 March 13
9	2005 2014	14.95 14.96	5.77 5.78	March 12 March 21

Table 4. Ten lowest maximum Arctic sea ice extents (satellite record, 1979 to present). http://nsidc.org/arcticseaicenews/2019/03/

Alaska had its warmest year on record in 2019 with a statewide average temperature of 32.2°F, 6.2°F above the long-term average. This surpassed the previous record of 31.9°F in 2016. Four of the last six years across Alaska have been record warm for the state. Along the northwest coast of Alaska, Utqiaġvik, Kotzebue, King Salmon, Bethel, and McGrath, each experienced their warmest year on record in 2019 (https://www.ncei.noaa.gov/news/national-climate-201912).

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

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). 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). Despite the oceans' role as large carbon sinks, the CO_2 level continues to rise and is currently 414 ppm.

As the oceans absorb more 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, 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 oceans have naturally lower saturation states of calcium carbonate minerals than more temperate or tropical waters (Fabry et al. 2009; Jiang et al. 2015), making Alaska's oceans more susceptible to the effects of ocean acidification. Large inputs of low-alkalinity freshwater from glacial runoff and melting sea ice reduce the buffering capacity of seawater to changes in pH (Reisdorph and Mathis 2014). As a result, seasonal undersaturation of aragonite has been 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).

Qi et al. (2017) found that the percentage of aragonite undersaturated area from 0 to 250 m in depth, in the Arctic increased from 5% in 1994 to 31% in 2010. They also suggest, based on modelling, that within approximately the next two decades, Arctic Ocean surface water will be entirely undersaturated with respect to aragonite (Qi et al. 2017). Undersaturated waters are potentially highly corrosive to any calcifying organism, such as corals, bivalves, crustaceans, echinoderms and many forms of zooplankton such as pteropods, and consequently may affect Arctic food webs (Bates et al. 2009, Fabry et al. 2009). Additionally, as the ocean becomes more acidic, low frequency sounds (1-3 kHz and below) travel farther because the concentrations of certain ions that absorb acoustic waves decrease with decreasing pH (Brewer and Hester 2009).

The 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). The years 2015–2016 coincided with the occurrence of the "blob" of exceptionally warm water in the North Pacific Ocean. This warmth became more extreme in the 2017–2019 period in association with the unprecedented loss of sea ice.

The winters of (2017–18 and 2018–19) experienced "marine heat waves" in the Bering Sea (Thoman and Walsh 2019). The heat content of the entire water column was greater in 2018 than ever recorded. The "cold pool" of water usually near the bottom of the Bering Sea disappeared during this time. This disappearance has major implications for the region, as the cold pool served as a barrier to northward migration of various aquatic species (Thoman and Walsh 2019). There have been increases of subarctic species seasonally found in the Chukchi Sea. With increasing sea-surface temperatures in the Arctic, and the loss of the cold water pool, the potential northward movement of sub-Arctic and non-native species increases (Nordon 2014).

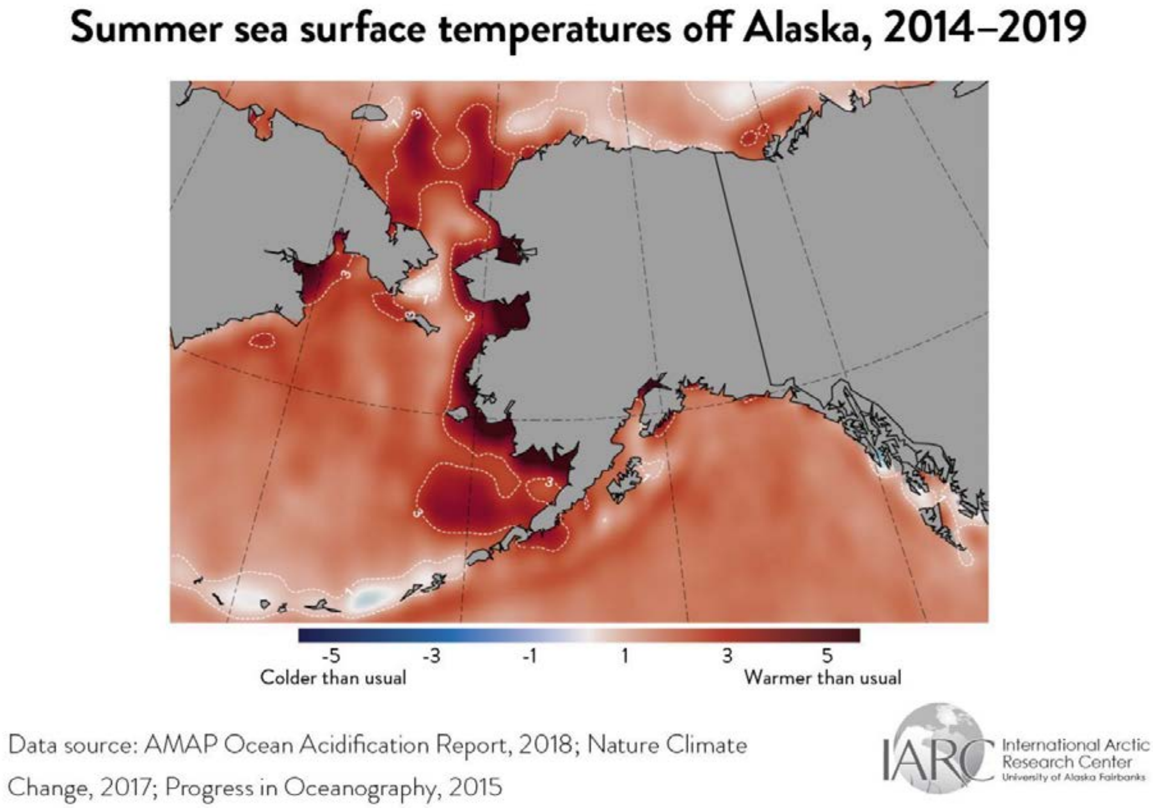

Figure 9. Arctic summer sea surface temperatures over the last 5 years.

Climate change is projected to have substantial direct and indirect effects on individuals, populations, species, and the structure and function of marine, coastal, and terrestrial ecosystems in the foreseeable future (Houghton 2001, McCarthy 2001, Parry 2007). Such changes have impacted, are impacting, and will continue to impact marine species in a variety of ways, such as (IPCC 2014):

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

Some of the anticipated biological consequences of the changing Arctic conditions are shown in Table 5**.**

Table 5. A summary of possible direct and indirect health effects for Arctic marine mammals (focus on seals) related to climate change (adapted from Burek et al. 2008).

Effect	Result
Direct Loss of sea ice platform	1. Reduction of suitable habitat for feeding, resting, molting, breeding. 2. Movement and distribution will be affected
Changes in weather	Reduction in snow, loss of suitable lair habitat
Ocean acidification	Alterations of prey base
Indirect Changes in infectious disease transmission (changes in host–pathogen associations due to altered pathogen transmission or host resistance)	1. Increased host density due to reduced habitat, increasing density-dependent diseases. 2. Epidemic disease due to host or vector range expansion. 3. Increased survival of pathogens in the environment. 4. 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 (harmful algal blooms, variation in long-range transport, biotransport, runoff, use of the Arctic)	1. Mortality events from biotoxins 2. Toxic effects of contaminants on immune function, reproduction, skin, endocrine systems, etc.
Other negative anthropogenic impacts related to longer open water period	1. Increased likelihood of ship strikes, fisheries interactions, acoustic injury 2. Chemical and pathogen pollution due to shipping or agricultural practices. 3. Introduction of nonnative species

Climate change is likely to have its most pronounced effects on species whose populations are already in tenuous positions (Isaac 2009). Therefore, we expect the extinction risk of at least some ESA-listed species to rise with global warming. The depth and duration of snow cover are projected to decline substantially throughout the range of the Arctic ringed seal, reducing the areas with suitable snow depths for their lairs by an estimated 70 percent by the end of this century (Hezel et al. 2012). A decrease in the availability of suitable sea ice conditions may not only lead to high mortality of ringed seal pups but may also produce behavioral changes in seal populations (Loeng et al. 2005). The persistence of this species will likely be challenged as decreases in ice and, especially, snow cover lead to increased juvenile mortality from premature weaning, hypothermia, and predation (Cameron et al. 2010, Kelly et al. 2010).

The persistence of Beringia DPS bearded seals will likely be challenged as reduction in the timing and extent of sea ice lead to spatial separation of sea ice from shallow feeding areas and decreases in ice suitable for molting and pup maturation, which will likely compromise their reproductive and survival rates (Cameron et al. 2010). With a progressively earlier spring breakup, the molt may be interrupted due to a lack of access to a stable ice surface and can result in compromised body condition and disease (Ferguson et al. 2017).

Although no scientific studies have directly addressed the impacts of ocean acidification on ringed and bearded seals, the effects would likely be through changes in their prey base (Bates et al. 2009). The decreased availability or loss of prey species from the ecosystem may have cascading trophic effects on these species (Kelly et al. 2010). However, the bearded and ringed seal's broad distribution, ability to undertake long movements, diverse diet, and association with widely varying ice conditions suggest they may be somewhat resilient in the face of environmental variability.

5.1.2 Biotoxins

As temperatures in the Arctic waters warm and sea ice diminishes, seal health may be compromised through nutritional and physiological stress, toxins from harmful algal blooms, and exposure to new pathogens. 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). In 2015, 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 10). 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). Three harmful algal blooms were documented in open water of the Chukchi Shelf in 2019 (NOAA 2019).

Figure 10. Algal toxins detected in 13 species of marine mammals from southeast Alaska to the Arctic from 2004 to 2013 (Lefebvre et al. 2016).

5.1.3 Disease

In addition to influencing animal nutrition and physiological stress, environmental shifts 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 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 (Van Wormer 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 (Van Wormer 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, an 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 (Mahoney 2019). Since June 1, 2018, NOAA Fisheries has confirmed at least 291 strandings (NMFS 2019b). 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 sampled in the last 2 years do not have the hair loss or skin lesions which were prominent in the prior UME. Subsistence hunters noted that some of the seals taken had less fat than normal, but if they otherwise appeared healthy, they were taken.

5.1.4 Predation

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

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. Gulls, ravens, and possibly snowy owls prey on ringed seal pups when the latter are forced out of subnivean lairs prematurely because of low snow accumulation and/or early melts (Kumlien 1879, Gjertz and Lydersen 1983, Lydersen and Gjertz 1987, Lydersen et al. 1987, Lydersen and Smith 1989, Lydersen and Ryg 1990, Lydersen 1998). Avian predation is facilitated not only by lack of sufficient snow cover but also by conditions favoring influxes of birds (Kelley et al. 2010).

5.1.5 Targeted hunts

While substantial commercial harvest of both ringed and bearded seals in the late 19th and 20th centuries led to local depletions, commercial harvesting of ice seals has been prohibited in U.S. waters since 1972 by the MMPA (Cameron et al. 2010, Kelly et al. 2010). Since that time, the only harvest of ringed and bearded seals allowed in U.S. waters is for subsistence by Alaska Natives. Ringed and bearded seals are important subsistence species for many northern coastal communities. Approximately 64 Alaska Native communities in western and northern Alaska, from Bristol Bay to the Beaufort Sea, regularly harvest ringed and bearded seals for subsistence purposes (Ice Seal Committee 2016).

Bearded and ringed seals are the most commonly harvested seals in the Kotzebue Sound area (Huntington et al. 2016). Bearded seals are the primary focus for Kotzebue Sound hunters in the spring, with harvests occurring near Cape Krusenstern and Goodhope Bay. In thinner ice years, there is less suitable denning habitat for ice seals and conditions are more dangerous for seal hunters. Hunters report that there is no longer ice for hunting bearded seals into July, as there was in the 1980s. Now the ice is all gone in June. In September, the yearling seals return to the Sound when the ice begins to form, spending time in the rivers feeding on fish until freeze-up (Huntington et al. 2016). Generally, hunters reported that there is less need for seal hunting than in the past because they are needed less for sled dog food and sealskin storage containers (Huntington et al. 2016).

The number of seals taken annually varies considerably between years due to ice and wind conditions, which impact hunter access to seals. The estimated annual harvests of bearded seals was 1,784 (SD = 941) from 1966 to 1977 (Burns 1981). Between August 1985 and June 1986, 791 bearded seals were harvested in five villages in the Bering Strait region based on reports from the Alaska Eskimo Walrus Commission (Kelly et al. 1988).

Cameron et al. (2010) noted that ice cover in hunting locations can dramatically affect the availability of bearded seals and the success of hunters in retrieving seals that have been shot, which can range from 50-75% success in the ice (Burns and Frost 1979, Reeves et al. 1992), to as low as 30% in open water (Burns 1967, Smith and Taylor 1977, Riewe and Amsden 1979, Davis and Koski 1980). Using the mean annual harvest reported from 1990-1998, assuming 25 to 50% of seals struck are lost, they estimated the total annual hunt by Alaska Natives would range from 8,485 to 10,182 bearded seals (Cameron et al. 2010).

A more recent estimate of subsistence harvest of ringed and bearded seals is available for 17 of 64 communities based on annual household surveys conducted from 2009 through 2014 (Table 6), but more than 50 other communities that harvest these species for subsistence were not surveyed within this time period or have never been surveyed. Household surveys are designed to estimate harvest for the specific community surveyed; extrapolation of harvest estimates beyond a specific community is not appropriate because of local differences in seal availability, cultural hunting practices, and environmental conditions (Ice Seal Committee 2017). From 2010 to 2014, the total annual ringed and bearded seal harvest estimates across surveyed communities ranged from 695 to 1,286 and 217 to 1,176, respectively (Table 6). However, it should be noted that the geographic distribution of communities surveyed varied among years such that these totals may be geographically or otherwise biased. Nelson et al. (2019) in an analysis of subsistence harvest data from 1992-2014 from 41 of 55 ice seal hunting communities determined that the subsistence harvest is sustainable.

Table 6. Alaska ringed and bearded seal harvest estimates based on household surveys, 2010–2014 (Ice Seal Committee 2017).

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

5.1.6 Anthropogenic Noise

The small population size of Kotzebue (approximately 3,000), its isolation, and the absence of any major industry near Kotzebue Sound indicates that the typical levels of anthropogenic sound are likely low.

5.1.7 Oil and Gas Development

The lease area closest to the action area is lease area 193 which is north of Kotzebue in the Chukchi Sea.

5.1.7.1 Noise Related to Oil and Gas Activities

In 2013, NMFS completed an incremental step consultation with BOEM and BSEE on the effects of the authorization of oil and gas leasing and exploration activities in the U.S. Beaufort and Chukchi Seas over a 14-year period, from March 2013 to March 2027 (NMFS 2013a). The incidental take statement issued with the biological opinion for the 14-year period allows for takes (by harassment) from sounds associated with high-resolution, deep penetration, and in-ice deep penetration seismic surveys of 5 species including 91,616 bearded seals, and 506,898 ringed seals. Take will be more accurately evaluated and authorized for project-specific consultations that fall under this over-arching consultation (i.e., stepwise consultations), and the cumulative take for all subsequent consultations will be tracked and tiered to these consultations.

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

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

No other consultations for oil and gas activities have been completed near the action area with the NMFS Permits Division since 2016. At this time there is little activity in the Chukchi lease sale area and nearly all lease holders have relinquished their holdings.

5.1.7.2 Oil Spills

Offshore petroleum exploration activities have been conducted in State of Alaska waters and the OCS of the Beaufort and Chukchi Sea Planning Areas since the late 1960s. Small oil spills have occurred with routine frequency and are considered likely to occur into the future (BOEM 2015b). Small spills during exploration activities are expected to consist of refined oils because crude and condensate oil would not be produced during exploration (BOEM 2015a).

From 1971-2010 industry drilled 84 exploration wells in the entire Alaska OCS (BOEM 2011). Within the action area of the Beaufort and Chukchi OCS, the oil industry drilled 35 exploratory wells. During the time of this drilling, industry has had 35 small spills totaling 1,120 gallons. Of the 1,120 gallons spilled, approximately 1,000 gallons were recovered or cleaned up (BOEM 2011).

There are no active oil wells near Kotzebue and most of the lease holdings in lease area 193 have been relinquished, reducing the likelihood of effects from accidental spills in the near future.

5.1.8 Other Arctic Projects

5.1.8.1 Prior consultations

In 2016, Fairweather proposed to retrieve approximately 55 anchors from five locations in the Chukchi and Beaufort Seas with the use of four specialized anchor handling towing supply vessels and sonar survey vessel. The Kotzebue location was approximately 20 kilometers km from Kotzebue. The incidental take statement issued with the biological opinion allowed takes by harassment of 5 species of listed marine mammals, including 6,895 ringed seals and 231 bearded seals.

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

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

An informal consultation was completed with Alaska Department of Transportation in 2019 for the use of barges in support of the Kotzebue Third Street sidewalk project.

5.1.8.2 Research

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

Permit No. 19309, which expired March 25, 2012, authorized the capture of up to 150 ringed seals and 150 bearded seals; takes by harassment of up to 3,000 of each species during capture operations and certain sampling activities; and takes by harassment of up to 3,200 bearded seals and 6,700 ringed seals during aerial surveys. Permit No. 20466, which expired March 31, 2012, authorized the capture of up to 200 bearded seals and 200 ringed seals; takes by harassment of up to 3,000 of each species during capture activities; and takes by harassment of up to 15,000 of each species during aerial and vessel surveys. Permit No. 18890, which expires June 15, 2021, authorizes the annual capture of 2 bearded seals and 2 ringed seals; and take by harassment of up to 8 of each species during vessel surveys. Permit No. 14856, which expires December 31, 2018, authorizes take by harassment of up to 100 ringed and 100 bearded seals during vessel surveys. Finally, Permit No. 20465, which expires May 31, 2022, authorizes take by harassment of up to 200 bearded seals and 200 ringed seals during aerial surveys.

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

5.1.9 Pollutants and Contaminants

The ocean is the ultimate repository of terrestrial matter and its associated human-made chemicals (Loganathan and Kannan 1994). As evidence, a large proportion of PCBs that have escaped into the global environment reside in coastal sediments and open-ocean waters, suggesting that the marine environment serves as a reservoir of persistent and semi-volatile organochlorines (Tanabe et al. 1994). Contaminants research on ringed seals is extensive throughout the Arctic environment where ringed seals are an important part of the diet for coastal human communities. Pollutants such as organochlorine compounds and heavy metals have been found in all of the subspecies of ringed seal except the Okhotsk subspecies. The variety, sources, and transport mechanisms of contaminants vary across ringed seal ecosystems (Kelly et al. 2010). There is a growing body of scientific literature on concentrations of metals and organochlorine chemicals (e.g., pesticides and polychlorinated biphenyls [PCBs]) in tissues of higher trophic level marine species, such as marine mammals, in cold-water environments (Dietz et al. 2013, McKinney et al. 2015).

There is particular concern about mercury in Arctic marine mammal food webs (MacDonald 2005). Mercury concentrations in marine waters in much of the Arctic are higher than concentrations in temperate and tropical waters due in large part to deposition of metallic and inorganic mercury from long-range transport and deposition from the atmosphere (Outridge et al. 2008). 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. 2009), and in some populations, are above multiple thresholds for neurological effects (Dietz et al. 2013).

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

An additional 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, strapping are problems for marine sea birds, turtles, and mammals because of ingestion and entanglement (Laist 1997, 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, increased number of observers (tourists, scientists, employees), and longer periods of open water which can promote delivery of plastics to the Arctic, it is anticipated that entanglement of ringed and bearded seals will be documented in coming years.

5.1.10 Vessel Traffic

The general seasonal pattern of vessel traffic in the Arctic is correlated with seasonal ice conditions, which results in the bulk of the traffic being concentrated within the months of July through October. Unaided navigation is limited to an even narrower time frame. Decreasing ice levels will facilitate an increase in vessel traffic associated with oil and gas exploration, tourism, and open historically closed trade routes. The extended open-ice season has already led to a slight increase in tourist vessel activity, scientific exploration in the Arctic, and new efforts at oil exploration in the Beaufort and Chukchi Seas. Several western Alaskan and Northwest Arctic communities are vying to be the first to construct a deep-water port in the Arctic, including the Cape Blossom project 12 miles south of Kotzebue as well as Nome, Point Hope, and Point Lay (PND 2020).

Degradation of Arctic marine ecosystems may accompany expanding vessel operations through increased air-borne emissions levels (CO2 and black carbon) increased underwater noise, potential for large oil spills, introduction of nonnative species, and probability of ship strike. These factors may compound stressors already affecting marine mammal populations due to climate change (Silber and Adams 2019).

5.1.10.1 Vessel Noise

Commercial shipping traffic is a major source of low frequency (5 to 500 Hz) human generated sound in the oceans (Simmonds and Hutchinson 1996, Nation Research Council 2003). The types of vessels operating in the Bering, Chukchi, and Beaufort seas typically include fishing vessels, barges, skiffs with outboard motors, icebreakers, scientific research vessels, and vessels associated with oil and gas exploration, development, and production. The primary underwater noise associated with vessel operations is the continuous noise produced from propellers and other on-board equipment. Cavitation noise is expected to dominate vessel acoustic output when tugs are pushing or towing barges or other vessels. Shipping sounds are often at source levels of 150 to 190 dB re 1 μPa at 1 m (BOEM 2011) with frequencies of 20 to 300 Hz (Greene and Moore 1995).

A limited number of studies have looked at seal behavior in response to vessel noise (Erbe et al. 2019). One response that has been observed with the use of tags that simultaneously record sound and behavior is a change in diving behavior (Mikkelsen et al. 2019, Erbe et al. 2019).

5.1.10.2 Ship Strikes

Ship strike of seals in open water occurs but is more likely where there are high concentrations of seals and boating activity (Swails 2005). To date, no bearded or ringed seal carcasses have been found with propeller marks. However, Sternfeld (2004) documented a singled spotted seal stranding in Bristol Bay, Alaska that may have resulted from a propeller strike. We have no reports of seals being struck by vessels in Kotzebue Sound.

5.1.11 Gear Entanglement

Ringed and bearded seals may be impacted by commercial fishing interactions as they migrate through the Bering Sea to the Chukchi Sea. Commercial fisheries may impact ringed and bearded seals through direct interactions (i.e., incidental take or bycatch) and indirectly through competition for prey resources and other impacts on prey populations. From 2010 through 2014, incidental mortality and serious injury of ringed seals was reported in 4 of the 22 federally-regulated commercial fisheries in Alaska monitored for incidental mortality and serious injury by fisheries observers: the Bering Sea/Aleutian Islands flatfish trawl, Bering Sea/Aleutian Islands pollock trawl, Bering Sea/Aleutian Islands Pacific cod trawl, and Bering Sea/Aleutian Islands Pacific cod longline fisheries (Muto et al. 2017). From 2013 to 2017, 1.6 bearded seals and 2.4 ringed seals were killed in commercial fisheries (Muto et al. 2019). In 2019, 4 bearded and 4 ringed seals were killed in commercial fisheries (NOAA 2020). If commercial fishing moves northward in response to a changing climate and changing fish distribution, interactions with bearded and ringed seals may rise.

6. EFFECTS OF THE ACTION

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

This biological opinion relies on the best scientific and commercial information available. We try to make note of 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 analyses using a stressor identification – exposure – response – risk assessment framework for the proposed exploration activities. Then we provide a description of the potential effects that could arise from the proposed action.

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.

6.1 Project Stressors

During our assessment, we identified four stressors associated with the proposed action. Based on our review of the data available, vibratory pile driving is the primary stressor.

1. in-water sound fields produced by continuous noise sources from vibratory pile driving
2. airborne sound
3. alterations to marine habitat
4. risk of collisions associated with proximity to the maneuvering and placement of sheet piles or temporary piles

6.1.1 Stressors Not Likely to Adversely Affect ESA-Listed Species

6.1.1.1 Airborne sound

Vibratory pile driving and extraction and the placement of fill behind sheet piles associated with this project will generate in-air noise above ambient levels. The predicted distances to the in-air noise disturbance threshold for hauled-out pinnipeds (100 dB re 20 μP arms) will extend less than or equal to 10 m from any pile being driven or extracted or from the placement of fill. Because construction will occur during the ice-free season, ice seals do not typically haul out on land, and a PSO will halt construction if any marine mammals appear within 10 m, no in-air disturbance to hauled-out bearded or ringed seals is anticipated as a result of this project.

6.1.1.2 Alterations to Habitat

During pile installation and removal, a temporary and localized increase in turbidity and sedimentation near the seafloor will occur in the immediate area surrounding each pile. In general, turbidity associated with pile installation is expected to be localized to about a 25-ft radius around the pile (Everitt et al. 1980). Adherence to BMPs including the use of sediment curtains around piles that are being driven will minimize the dispersal of sediment. Implementation of best management practices and local currents and tidal action are expected to minimize and disperse turbidity that is created.

Ringed and bearded seals are not expected to come close enough to the immediate project site to encounter increased turbidity during pile driving or removal activities. 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 or from stream runoff is likely a regular occurrence in their habitat.

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 at this location will cause any measurable loss of prey. In addition, the size of the project footprint is very small in relationship to Kotzebue Sound. Any loss of food resources that may occur in the project area would be exceedingly small in comparison to those available in the Sound.

Short-term effects on listed marine mammal species may occur if petroleum or other contaminants accidentally spill into the Sound from machinery or vessels during construction activities. Assuming normal construction and vessel activities, any discharges of petroleum hydrocarbons are expected to be small and are not expected to result in high concentrations of contamination within the surface waters. BMPs will be implemented to minimize the risk of fuel spills and other potential sources of contamination.

On-site containment equipment will be readily available prior to any construction activities, and per the mitigation measures, equipment will be inspected daily. Spill prevention and spill response procedures will be maintained throughout construction activities. If any small spills occur, most the spilled fuel is likely to evaporate quickly and we expect the effects on bearded and ringed seals to be immeasurably small.

6.1.1.3 Collisions/physical harm

The project will require the placement and maneuvering of 650 sheet piles and the installation and removal of 170 temporary piles. There is the possibility that a ringed or bearded seal could be injured as one of these piles is being maneuvered and placed into position. However, there will be a PSO at the dock site observing a 10 m zone to ensure that work stops if a seal enters that zone. This mitigation measure will prevent physical harm and collisions from occurring to bearded or ringed seals.

6.1.2 Stressors Likely to Adversely Affect ESA-Listed Species

The stressor associated with the Crowley Fuels dock expansion project that is likely to adversely affect ringed and bearded seals is underwater noise from pile installation and removal. This stressor is analyzed below in the Exposure Analysis 6.3.

6.2 Acoustic Thresholds

Since 1997, NMFS has used generic sound exposure thresholds to determine whether an activity produces underwater and in-air sounds that might result in impacts to marine mammals (70 FR 1871. 1872; January 11, 2005). NMFS recently developed comprehensive guidance on sound levels likely to cause injury to marine mammals through onset of permanent and temporary thresholds shifts (PTS; Level A harassment) (83 FR 28824; June 21, 2018). NMFS is in the process of developing guidance for behavioral disruption (Level B harassment). However, until such guidance is available, NMFS uses the following conservative thresholds of underwater sound pressure levels[1], expressed in root mean square[2] (rms), from broadband sounds that cause behavioral disturbance, and referred to as Level B harassment under section 3(18)(A)(ii) of the Marine Mammal Protection Act (MMPA):

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

Under the PTS Technical Guidance, NMFS uses the following thresholds (Table 7) for underwater sounds that cause injury, referred to as Level A harassment under section 3(18)(A)(i) of the MMPA (16 U.S.C § 1362(18)(A)(i)) (NMFS 2018). Different thresholds and auditory weighting functions are provided for different marine mammal hearing groups, which are defined in the Technical Guidance (NMFS 2018). The generalized hearing range for each hearing group is in Table 7. 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

[1] 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.

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

spreadsheet[3] associated with NMFS Acoustic Guidance, or through modeling.

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

- 100 dB re 20µParms for non-harbor seal pinnipeds

Table 7. PTS Onset Acoustic Thresholds for Level A Harassment (NMFS 2018).

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

* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.

Note: Peak sound pressure (L_{pk}) has a reference value of 1 µPa, and cumulative sound exposure level (L_E) has a reference value of 1µPa²s. 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"

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

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, we consider any exposure to Level B behavioral disturbance sound thresholds to constitute harassment under the ESA.

As described below, we anticipate that exposures to listed marine mammals from noise associated with the proposed action may result in disturbance due to exposure to sound capable of causing Level B harassment. With the addition of mitigation measures including shutdown zones, no mortalities or permanent impairment to hearing are anticipated.

6.3 Exposure Analysis

As discussed in the Approach to the Assessment section of this opinion, exposure analyses are designed to identify the listed resources that are likely to co-occur with these effects in space and time and the nature of that co-occurrence. In this step of our analysis, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent.

During the course of this consultation, we identified sounds from vibratory pile driving and extraction as the stressor likely to affect ringed and bearded seals.

6.3.1 Exposure to Noise from pile driving

Ringed and bearded seals may be present within the waters of the action area during vibratory pile driving and could be exposed to temporarily elevated underwater noise levels resulting in harassment.

For this analysis we estimated take by considering: 1) acoustic thresholds above which the best available science indicates listed marine mammals will be behaviorally harassed; 2) the area that will be ensonified above these levels in a day; 3) the expected density or occurrence of listed marine mammals within these ensonified areas; and 4) the number of days of activities.

6.3.1.1 Exposure Assumptions

- Because pile driving and 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 action 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.
- 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.

- Exposures to sound levels at or above the relevant thresholds equate to take.
- A practical spreading value of 15 is a conservative but appropriate value for the transmission loss coefficient in the absence of site-specific information.
- Because the life history of the bearded and ringed seals is closely associated with ice, we assume that more seals are present in and near the action area when ice is present (spring) than when it is not (summer).

6.3.1.2 Calculated Acoustic Impact Zones

Reference sound levels for vibratory and impact piling and drilling activities were derived from sound source verification (SSV) studies conducted during construction projects using the same size or similar sized materials with vibratory pile driving. Source levels (at 10 m) for these activities are shown in Table 2.

For in-water sound transmission, the radius of the applicable Level B threshold is calculated by the equation:

$$RL = SL - TL\ (\text{Log}_{10}\ R)$$

where RL is received level of sound, SL is the level source (1 m), TL is the transmission loss coefficient, and R is the radius at which the source level will have attenuated to the desired (160 or 120 dB) received level. Transmission loss, also referred to as spreading loss, is the decrease in acoustic intensity as an acoustic pressure wave propagates out from a source. TL parameters vary with frequency, temperature, sea conditions, current, source and receiver depth, water depth, water chemistry, and bottom composition and topography. Because TL is affected by so many variables, NMFS often defaults to a "practical spreading loss" of 15, which was done for the calculations for this project.

Using the practical spreading value in the above equation, we determined underwater noise will fall below the behavioral effects threshold of 120 dB rms for marine mammals at a distance of 5,168 m for vibratory piling of sheet piles, 3,871 m for 14" H-piles, and 3,414 m for 18" template piles. This information is summarized in Table 2.

Based on these calculations, the Level B harassment zone was estimated at 5,168 m from the sound source for continuous sounds made by vibratory pile driving/removal (Tables 2 and Table 8). The Level A zones are all less than 10 m but there will be a 10 m shutdown zone to prevent any physical harm from occurring by construction activities. Because there will be a PSO on the dock while construction is occurring, and pile driving will stop if a marine mammal were to enter the shutdown zone, no Level A take is expected to occur.

Table 8. Estimated area ensonified above the Level B harassment take threshold, and estimated days of construction for each activity.

Activity	Level A Harassment Zone (m)	Level B Harassment Zone (m)
Template Piles (18-in Pipe Pile)	3.7	3414.5
Alternate Template Piles (14-in H-piles)	4.2	3860.7

Activity	Level A Harassment Zone (m)	Level B Harassment Zone (m)
Anchor Piles (14-in H-piles)	4.2	3860.7
Sheet Piles	5.2	5168.1

Table 9. Estimated area ensonified above the Level B harassment take threshold, and estimated days of construction for each activity.

Pile Size	**Estimated Area Ensonified Above Level B Harassment Take Threshold (km^2)**	**Estimated Days of Construction[a]**
Template Piles (18-in Pipe Pile)	24.8	39[b]
Alternate Template Piles (14-in H-piles)	32.1	39[b]
Anchor Piles (14-in H-piles)	32.1	3
Sheet Piles	52.5	50

[a] FRN 2020
[b] Includes both installation and removal.

6.3.1.3 Anticipated Densities and Exposures of Bearded Seals

Recent density estimates for bearded seals in the action area are not available. Bearded seal densities just outside of Cape Krusenstern were 0.001 - 0.7 bearded seals per seals per km^2 (Bengtson et al., 2005). In 1976 aerial surveys of bearded seals in the Bering Sea, densities ranged between 0.006 and 0.782 seals per seals per km^2. Bearded seals were typically spotted in groups of one to two individuals with occasional larger groupings in denser areas (Braham et al. 1984). Bengtson et al. (2005) includes bearded seal densities calculated from aerial surveys in May and June 1999 and May 2000, but the density for the project area was 0 in both years. However, data show that at least some bearded seals are nearby from June to September and could potentially enter the project area (Bengtson et al. 2005, Huntington et al. 2016b, Quakenbush et al. 2019). Therefore, in the absence of more recent data, NMFS determined that 0.782 (Braham et al.1984) is the most appropriate density to use for this analysis, considering those available.

Given the known association between ice cover and bearded seal density, NMFS estimates that bearded seal density will be highest when the project begins in June when sea ice may still be in the area and will taper off as the ice melts (ADFG 2014, Quakenbush et al. 2019). Although some seals may remain in the area, tagging studies and local knowledge indicate that there are fewer seals in Kotzebue Sound in the summer (ADFG 2014, Huntington et al. 2016b, Quakenbush et al. 2019). As such, NMFS has estimated take for the month of June separately from the remainder of the expected project period (July through September).

As noted in section 2.2 Proposed Activities, Crowley will construct the dock upgrade one cell at a time, with construction of each cell requiring approximately one week. In an effort to separate out work that will occur in June, when seal densities are expected to be higher, NMFS made several assumptions: (1) While there are 14 cells and construction of each is expected to require approximately one week, NMFS estimates that construction of all cells will last 15 weeks to account for potential delays or other unforeseen circumstances; (2) NMFS assumes that each cell will require the same number of each pile type, and therefore the same duration for installation (and removal of template piles); (3) Based on information provided by Crowley, NMFS assumes that construction will require approximately 90 in-water workdays; and (4) NMFS assumes that the best density available is 0.782 (Braham et al. 1984). Given these assumptions, NMFS estimates 967 bearded seal takes in the month of June (sum of Takes per Activity in (Table 10).

Table 10. NMFS assumptions for bearded seal June take estimate.

Pile Type	Assumed Duration for Project (days)[a]	Assumed Duration Per Cell (days)[d]	Anticipated Days in June[e]	Area of Level B Harassment Zone (km^2)	Take per Activity[f]
Template Piles[b]	39[c]	3.0	12.1	24.8	305
Anchor Piles (14-in H-piles)	3	0.2	0.93	32.1	23
Sheet Piles	50	3.9	15.6	52.5	639

[a] Average of applicant's expected duration (see p. 27 in application) and buffered duration (see p. 32 in application).
[b] Conservatively assumes 14-inch H-piles rather than 18-inch pipe piles.
[c] Includes installation and removal
[d] Assumed Duration for Project/90 = Assumed Duration per Cell/7
[e] Assumed Duration per Cell x 4 weeks of June
[f] Anticipated Days in June x Area of Level B Harassment Zone x Density (0.782/km^2)

During the months of July to September, NMFS expects that the number of bearded seals in the project area will be much lower due to the lack of sea ice. NMFS considered the relative number of ringed and bearded seal locations reported in Quakenbush et al. (2019, Figures 7, 30, and 55), and estimates that approximately twice as many bearded seals (2-4 per day) are likely to occur in the project area as ringed seals (1-2 per day), because tagging studies show that nearly all of the ringed seals spend the summer north of Point Hope (Figures 30 and 55 in Quakenbush et al. 2019). NMFS estimates that approximately 14 Level B harassment takes of bearded seals takes may occur each week (2 seals times 7 days).

Assuming 15 weeks of construction total, with four weeks of construction in June, NMFS estimates that Crowley will conduct pile driving activities for 11 weeks from July through September. To estimate bearded seal takes during that period, NMFS multiplied the estimated weekly take estimate (14) by the estimated number of weeks of construction, for a total of 154 Level B harassment takes from July to September (14 bearded seals x 11 weeks of construction = 154 Level B harassment takes). Therefore, throughout the entire project period, NMFS estimates 1,121 Level B harassment takes of bearded seals (967 estimated takes in June + 154 estimated takes from July to September).

The largest Level A harassment zone for phocids extends 5.2 m from the source during vibratory installation of the sheet piles (Table 8, Figure 4). Crowley is planning to implement a 10 m shutdown zone during all construction activities, which, given the extremely small size of the Level A harassment zones, is expected to eliminate the potential for Level A harassment take of bearded seals. Therefore, takes of bearded seal by Level A harassment are not expected.

6.3.1.4 Anticipated Densities and Exposures of Ringed Seal

Ringed seals are distributed throughout Arctic waters in all seasonally ice-covered seas. In winter and early spring when sea ice is at its maximum coverage, they occur in the northern Bering Sea, in Norton and Kotzebue Sounds, and throughout the Chukchi and Beaufort seas. In years with particularly extensive ice coverage, they may occur as far south as Bristol Bay (Muto et al. 2019). In 1976 aerial surveys of ringed seals in the Bering Sea, densities ranged between 0.005 and 0.017 seals per seals per km^2 (Braham et al. 1984). Surveys of seals in their breeding grounds in the Sea of Okhotsk in 1964 found a density of 0.1 to 2 seals per km^2 (CNRC 1965). Bengtson et al. 2005 includes ringed seal densities calculated from aerial surveys in May and June 1999 and May 2000. Densities for the waters surrounding Kotzebue ranged from 3.82 (2000) to 5.07 (1999).

Given the known association between ice cover and ringed seal density, NMFS estimates that ringed seal density will be highest when the project begins in June and will taper off as the ice melts (ADFG 2014, Huntington et al. 2016b, Quakenbush et al., 2019). As such, NMFS has estimated take for the month of June separately from the remainder of the expected project period (July through September).

For the calculation of ringed seal take, NMFS made all of the same assumptions as was done for bearded seal. NMFS assumes that the density of ringed seals is likely to be 5.07 animals/km^2 (Bengtson et al. 2005). Given these assumptions NMFS estimates 6,268 ringed seal takes in the month of June (sum of Takes per Activity in Table 11).

Table 11. NMFS assumptions for ringed seal June take estimate using a density of 5.07 animals/km2.

Pile Type	Assumed Duration for Project (days)[a]	Assumed Duration Per Cell (days)[c]	Anticipated Days in June[d]	Area of Level B Harassment Zone (km^2)	Take per Activity[e]
Template Piles (18-in Pipe Pile)	39[b]	3.0	12.1	24.8	1,975
Anchor Piles (14-in H-piles)	3	0.2	0.93	32.1	152
Sheet Piles	50	3.9	15.6	52.5	4,141

[a] Average of applicant's expected duration (see p. 27 in application) and buffered duration (see p. 32 in application).
[b] Includes installation and removal
[c] Assumed Duration for Project/90 = Assumed Duration per Cell/7
[d] Assumed Duration per Cell x 4 weeks of June
[e] Anticipated Days in June x Area of Level B Harassment Zone x Density (5.07/km^2)

During the months of July to September, NMFS expects that the number of ringed seals in the action area will much lower due to the lack of sea ice. NMFS considered the relative number of ringed and bearded seals locations reported in Quakenbush et al. (in Figures 7, 30 and 55 Quakenbush et al. 2019), and estimates that approximately twice as many bearded seals (2-4 per day) are likely to occur in the project area as ringed seals (1-2 per day). NMFS estimates that approximately seven Level B harassment takes of ringed seals takes may occur each week. Assuming 15 weeks of construction with four weeks of construction in June, NMFS estimates that Crowley will conduct pile driving activities for 11 weeks from July through September. To estimate ringed seal takes during that period, NMFS multiplied the estimated weekly take estimate by the estimated number of weeks of construction, for a total of 77 Level B harassment takes (7 ringed seals x 11 weeks of construction = 77 Level B harassment takes from July to September).

Therefore, throughout the entire project period, NMFS estimates 6,345 Level B harassment takes of ringed seals (6,268 estimated takes in June + 77 estimated takes from July to September).

The largest Level A harassment zone for phocids extends 5.2 m from the source during vibratory installation of the sheet piles. Crowley is planning to implement a 10 m shutdown zone during all construction activities, which, given the extremely small size of the Level A harassment zones, is expected to eliminate the potential for Level A harassment take of ringed seals. Therefore, takes of ringed seal by Level A by harassment are not reasonable certain to occur.

6.4 Response Analysis

As discussed in the Approach to the Assessment section of this opinion, response analyses determine how listed species are likely to respond after being exposed to an action's effects on the environment or directly on listed species themselves. Our assessments try to detect the probability of lethal responses, physical damage, physiological responses (particularly stress responses), behavioral responses, and social responses that might result in reducing the fitness of listed individuals. Ideally, our response analyses consider and weigh evidence of adverse consequences, beneficial consequences, or the absence of such consequences.

As described in the Exposure Analysis (6.3), bearded and ringed seals are anticipated to occur in the action area and to overlap with noise from pile removal and installation. Some of the in-water sound source levels from the proposed action will generate noise loud enough to harass these species at certain distances.

The effects of project-related noise on marine mammals depend on both physical and biological factors. Physical factors include the sound magnitude, duration, and type (e.g., continuous vs. pulse), the size, type, and depth of the animal; the depth of the water column; the substrate of the habitat; the distance between the pile and the animal; and the sound propagation properties of the environment. Biological factors influencing an individual's response include the species receiving the sound, and individual characteristics such as habituation, season, or motivation (Ellison *et al*. 2012).

Marine mammals depend on acoustic cues for vital biological functions (e.g., orientation, communication, finding prey, avoiding predators). In general, the effects of sounds from vibratory pile driving, vibratory pile removal, and drilling could result in one or more of the following:

- temporary or permanent hearing impairment;
- non-auditory physical or physiological effects;

- behavioral disturbance, and
- masking (Gordon 2007; Nowacek et al. 2007; Richardson et al. 1995; Southall et al. 2007).

Marine mammals exposed to high intensity sound repeatedly or for prolonged periods can experience hearing threshold shift (TS), which is the loss of hearing sensitivity at certain frequency ranges (Kastak et al. 1999, Schlundt et al. 2000, Finneran et al. 2005). TS can be permanent (PTS), in which case the loss of hearing sensitivity is not recoverable, or temporary (TTS), in which case the animal's hearing threshold would recover over time (Southall et al. 2007). Marine mammals depend on acoustic cues for vital biological functions, (e.g., orientation, communication, finding prey, avoiding predators); thus, TTS may result in reduced fitness in survival and reproduction. However, this depends on the frequency and duration of TTS, as well as the biological context in which it occurs. TTS of limited duration, occurring in a frequency range that does not coincide with that used for recognition of important acoustic cues, would have little to no effect on an animal's fitness. Repeated sound exposure that leads to TTS could cause PTS. PTS constitutes injury, but TTS does not (Southall et al. 2007). The following subsections discuss in somewhat more detail the possibilities of TTS, PTS, and non-auditory physical effects.

6.4.1 Temporary Threshold Shift

TTS of limited duration, occurring in a frequency range that does not coincide with that used for recognition of important acoustic cues, would have little to no effect on an animal's fitness. Repeated sound exposure that causes TTS could result in PTS. As stated in the Exposure analysis, we anticipate no Level A harassment, equivalent in this case to PTS, from the proposed project. There will be numerous pauses in activities producing the sounds each day. Given these pauses and the fact that many marine mammals are moving through the ensonified area and not remaining for extended periods of time, reduces the potential for threshold shift declines.

6.4.2 Non-Auditory Physiological Effects

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 could experience physiological stress responses upon exposure to intense and repeated sounds.

The Crowley Fuels dock expansion will be staggered over a 3-month period and occur for a limited amount of time on each day (Table 9), thus limiting the potential for chronic stress. Seals that show behavioral avoidance of pile driving are especially unlikely to incur auditory impairment or non-auditory physiological effects because of this project.

6.4.3 Disturbance Reactions

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).

It is likely that the onset of vibratory driving could result in short-term changes in an animal's behavior. These behavioral changes may include: changing durations of surfacing and dives; moving direction and/or speed; reduced/increased vocal activities; changing/cessation of certain behavioral activities (such as socializing or feeding); visible startle response or aggressive behavior (such as tail/fluke slapping or jaw clapping); avoidance of areas where sound sources are located; and/or flight responses (*e.g.*, pinnipeds flushing into water from haulouts or rookeries).

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 they and 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 ringed seals could react to the continuous sounds created by the vibratory pile driving at Crowley Dock 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 biological significance of marine mammals' behavioral responses to pile driving is difficult to predict, and in some cases, may not occur at all. For example, 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%) 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). Although phocid seals are different from their otariid sea lion cousins, it is not unreasonable to expect that a wide range of behaviors would also be observed for ringed and bearded seals near the Crowley Dock ranging from a non-response to fleeing of the area.

6.4.4 Masking

Auditory interference, or masking, occurs when a noise is similar in frequency and loudness to (or louder 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, such as 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.

The Crowley Dock expansion project will occur in a relatively busy harbor, where vessel sounds and dock activity likely occurs frequently. We expect any additional contributions to masking from project activities would be very small and of short duration relative to the existing conditions. The short duration and limited affected area of Crowley project-related noise will likely result in an insignificant amount of masking. Any masking that could possibly rise to Level B harassment would occur concurrently within the zones of behavioral harassment already estimated for vibratory pile driving.

6.4.5 Effects on Potential 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. 2005) which is being used in this project. Prolonged (more than one hour), close (<10m) exposure could potentially affect the hearing of fish (Burgess et al. 2005), but it is highly unlikely that this kind of exposure would occur in a natural setting. It is unlikely that vibratory impact driving would have an effect on prey species used by ringed or bearded seals.

There will be a slight increase in turbidity in the water near the pile driving. The effects resulting from sediment suspension will be localized in space and are not expected to persist in the area for more than a few hours as tidal action will sufficiently disperse them to a point where their concentration in the water column is not detectable from the surrounding waters. Therefore, it is unlikely that the increase in turbidity will have any measurable effect on prey species.

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 that are prey for ringed or bearded seals. Thus, any impacts to marine mammal habitat are not expected to cause significant or any long-term consequences for individual ringed or bearded seals.

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.

7.1 Transportation

Regularly occurring vessel traffic in the action area can be generally characterized as cargo vessels, barges, recreational craft, or boats used for subsistence harvest. Cruise ships do not use the Crowley Fuels Dock. The proposed modification of the dock is expected to improve safety and efficiency of cargo vessels using the dock, but it is not being improved for the purpose of increasing vessel capacity. The Crowley Fuel dock is used by cargo vessels to get supplies to the community of Kotzebue and surrounding villages. It is unlikely that there will be a significant increase in demand of goods by these communities. Thus, NMFS assumes that the amount and frequency of use of the improved dock is unlikely to change in the near future.

7.2 Commercial Fishing

Commercial fishing is expected to continue into the future at a level comparable to current effort and is expected to continue to result in periodic interactions with bearded and ringed seals. As sea ice distribution and extent and ocean temperatures continue to change, there may be increasing interactions between seals and fisheries if commercial fishing expands northward.

7.3 Summary of Cumulative Effects

The action area will likely continue to function as a localized water-based transit station, especially for barges, cargo ships, and recreational vessels. Restrictions in capacity at the dock, low demand, and low expected population growth in the area will likely limit substantial growth. Tourism activities may increase as ice extent declines and the open water season increases. NMFS did not find any information about planned non-Federal actions other than what has already been described in the *Environmental Baseline* (see Section 5). We expect climate change, fisheries interactions, harvest, noise, oil and gas activities, exposure to pollutants and contaminants, and scientific research will continue into the future. We expect moratoria on commercial sealing will remain in place.

8. INTEGRATION AND SYNTHESIS

The Integration and Synthesis section is the final step of NMFS's assessment of the risk posed to listed species by 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 survival of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) result in appreciable reductions in the likelihood of recovery of the species in the wild by reducing its numbers, reproduction, or distribution. These assessments are made in full consideration of the status of the species (Section 4).

As we discussed in the Approach to the Assessment section of this opinion, we begin our risk analyses by asking whether the probable physical, physiological, behavioral, or social responses of endangered or threatened species are likely to reduce the fitness of endangered or threatened individuals or the growth, annual survival or reproductive success, or lifetime reproductive success of those individuals. If we would not expect individuals of the listed species exposed to an action's effects to experience reductions in the current or expected future survivability or reproductive success (that is, their fitness), we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (Stearns 1977, Brandon 1978, Stearns 1992a, Anderson 2000). Therefore, if we conclude that individuals of the listed species are not likely to experience reductions in their fitness, we would conclude our assessment because we would not expect the action to affect the performance of the populations those individuals represent or the species those populations comprise. If, however, we conclude that individuals of the listed species are likely to experience reductions in their fitness as a result of their exposure to an action, we then determine whether those reductions are likely to reduce the viability of the population or populations the individuals represent and the "species" those populations comprise (species, subspecies, or distinct populations segments of vertebrate taxa).

As part of our risk analyses, we consider the consequences of exposing endangered or threatened species to 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 discussed in Section 6.1.1, airborne sound, habitat alteration, and potential collisions associated with proximity to the maneuvering and placement of sheet piles or temporary piles could affect ringed and/or bearded seals. However, because of the limited transmission of airborne sound, the small spatial and temporal increases in turbidity, and the implementation of mitigation measures, we expect the effects from these stressors to be either immeasurably small or extremely unlikely to occur.

Based on the results of the Exposure Analysis (6.3), we expect ringed and bearded seals to be exposed and respond to vibratory pile driving noise. Our consideration of probable exposures and responses of pinnipeds to noise stressors associated with pile driving activities in the action area are designed to help us assess whether those activities are likely to increase the extinction risks facing listed pinnipeds, impede recovery, or jeopardize their continued existence.

The primary mechanism by which the behavioral changes we have discussed affect the fitness of individual animals is through the animal’s energy budget, time budget, or both (the two are related because foraging requires time). However, the individual and cumulative energy costs of the behavioral responses we have discussed are not likely to reduce the energy budgets of ringed and bearded seals. As a result, the ringed and bearded seals’ probable responses (i.e., tolerance, avoidance, short-term masking, and short-term vigilance behavior) near the project area are not likely to reduce their current or expected future reproductive success or reduce the rates at which they grow, mature, or become reproductively active. Therefore, these exposures are not likely to reduce the abundance, reproduction rates, and growth rates (or increase variance in one or more of these rates) of the populations those individuals represent.

We estimated 6,345 instances of ringed seal exposure and 1,121instances of bearded seal exposure vibratory pile driving activities from the proposed action (see Sections 6.3.1.3 and 6.3.1.4) at received levels sufficiently high (or distances sufficiently close) that might result in behavioral harassment (Section 6.4, Response Analysis). No ringed or bearded seals are anticipated to be exposed to sound levels that could result in TTS or PTS.

These estimates represent the total number of takes that could potentially occur, not necessarily the number of individuals that will be taken, as a single individual may be taken multiple times over the course of the proposed action. These exposure estimates are likely to be overestimates because they assume a uniform distribution of animals, do not account for avoidance, and assume maximum density of listed species based on the best available information.

For pile driving, PSOs will be able to see the entire shutdown zone, but will be unable to see the entire Level B harassment zone. PSOs will keep track of the potential take that could occur within the Level B harassment zone. Considering that the pile driving will be a continuous source of underwater noise, it is not anticipated that marine mammals would enter into an area where they would suffer from acoustic harassment.

Although the pile driving activities are likely to cause some individual ringed and bearded seals to experience changes in their behavioral states that might have adverse consequences (Frid and Dill 2002), these responses are not likely to alter the physiology, behavioral ecology, or social dynamics of individual ringed seals in ways or to a degree that would reduce their fitness. In most circumstances, ringed and bearded seals are likely to avoid ensonified areas that may cause TTS. Ringed and bearded seals that avoid these sound fields or exhibit vigilance are not likely to experience significant disruptions of their normal behavior patterns. Southall et al. (2007) reviewed literature describing responses of pinnipeds to continuous sound and reported that the limited data suggest exposures between ~90 and 140 dB re 1 μPa generally do not appear to induce strong behavioral responses in pinnipeds exposed to continuous sounds in water.

As discussed in Section 3, Approach to the Assessment, of this opinion, an action that is not likely to reduce the fitness of individual seals would not be likely to reduce the viability of the populations those individual seals represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of such populations). For the same reasons, an action that is not likely to reduce the viability of those populations is not likely to increase the extinction probability of the species those populations comprise; in this case, the ringed and bearded seal. As a result, the pile driving activities that the Corps of Engineers plans to authorize and the incidental take that PR1 plans to authorize are not likely to appreciably reduce the ringed or bearded seals' likelihood of surviving or recovering in the wild.

9. CONCLUSION

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Arctic subspecies of ringed seal (*Phoca hispida hispida*) or the Beringia DPS of bearded seal (*Erignathus barbatus nauticus*). No critical habitat has been designated for these species, therefore, none will be affected.

10. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species unless there is a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (16 U.S.C. § 1532(19)). "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity (50 CFR § 402.02). Based on NMFS guidance, the term "harass" under the ESA means to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (Wieting 2016). The MMPA defines "harassment" as any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment] (16 U.S.C. § 1362(18)(A)(i) and (ii)).

In this opinion, we have considered potential exposures of ringed and bearded seals to stressors from the proposed action. For any given exposure, it is impossible to predict the exact impact to individual marine mammals because an individual's reaction depends on a variety of factors (the individual's sex, reproductive status, age, activity engaged in at the time, etc.). Therefore, we estimate potential instances of exposure and assume these exposures constitute takes. We find this approach conservative for evaluating jeopardy under the ESA since the exposure estimates are likely over-estimates, and since an instance of exposure may not actually result in any measurable adverse effect. Notwithstanding that fact, the exposure estimates reflect the best scientific and commercial data available.

Under the terms of Section 7(b)(4) and Section 7(o)(2) of the ESA, taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA, provided that such taking is in compliance with the terms and conditions of an Incidental Take Statement (ITS).

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

The terms and conditions described below are nondiscretionary. The Corps of Engineers and NMFS PR1 have a continuing duty to regulate the activities covered by this incidental take statement. In order to monitor the impact of incidental take, the Corps and NMFS PR1 must monitor the progress of the action and its impact on the species as specified in the incidental take statement (50 CFR 402.14(i)(3)). .

10.1 Amount or Extent of Take

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

Species	Proposed Authorized Level A Takes	Proposed Authorized Level B Takes	Anticipated Temporal Extent of Take
Bearded seal (*Erignathus barbatus nauticus*)	0	1,121	June 1, 2020 to September 1, 2020
Ringed seal (*Phoca hispida hispida*)	0	6,345	

10.2 Effect of the Take

In Section 9 of this opinion, we determined that the level of anticipated take, coupled with other effects of the proposed action, is not likely to jeopardize the continued existence of ringed or bearded seals. The anticipated takes from the proposed action are associated with behavioral harassment from acoustic noise. Although the biological significance of behavioral responses remains unknown, this consultation has assumed that exposure to major noise sources might disrupt one or more behavioral patterns that are essential to an individual animal’s life history. However, any behavioral responses of these pinnipeds to major noise sources and any associated disruptions are not expected to affect the fitness, reproduction, survival, or recovery of the species.

10.3 Reasonable and Prudent Measures (RPM)

“Reasonable and prudent measures” are nondiscretionary measures necessary or appropriate to minimize the amount or extent of incidental take (50 CFR 402.02). The RPMs included below, along with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. NMFS concludes that the following RPM is necessary and appropriate to minimize or to monitor the incidental take of bearded and ringed seals resulting from the proposed action.

1. PR1 and the Corps will document and report on the implementation of the mitigation measures, SOPs, BMPs and compliance with permits.

10.4 Terms and Conditions

“Terms and conditions” implement the reasonable and prudent measures (50 CFR 402.14).

The Corps and NMFS PR1 must comply with the following terms and conditions, which implement the reasonable and prudent measures described above, the mitigation measures set forth in Section 2.1.2 of this opinion, and reporting/monitoring requirements described in the MMPA authorization.

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

To carry out RPM #1, NMFS PR1, the Corps, or their authorization holder must undertake the following:

A. NMFS PR1 and the Corps shall require their permitted operator to possess a current and valid Incidental Harassment Authorization (IHA) issued by NMFS under section 101(a)(5) of the MMPA, and any take must occur in compliance with all terms, conditions, and requirements included in such authorizations.

B. Crowley must adhere to all monitoring and reporting requirements as detailed in the IHA issued by NMFS under section 101(a)(5) of the MMPA.

C. The monitoring program described in Section 2.3 of this opinion must be followed, and the observation and shut down zones must be fully observed in order to adequately document observed incidents of harassment as described in the mitigation measures associated with this action.

D. The Corps and PR1 will notify NMFS AKR of project start and end dates.

E. If the number of takes approaches 75% of the total amount authorized, PR1 must send that information in a report to Greg.Balogh@noaa.gov within 5 business days. That report must contain a description of the amount of project activity remaining at that point.

11. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

1. We recommend that PR1 summarize findings from past IHA holders to document how much take of bearded and ringed seals has been authorized (Level A and B) vs how much take has been documented.
2. Because of the ongoing Unusual Mortality Event for ice seals, in the event that a sick, diseased, emaciated, or stranded seal is seen by the PSOs or any Crowley employees, we request that they report the incident immediately to the AKR Stranding Hotline at 1-877-925-7773.

In order to keep NMFS AKR informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NMFS PR1 and the Corps should notify NMFS AKR of any conservation recommendations implemented in the 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 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 or extent of incidental take is exceeded, section 7 consultation must be reinitiated immediately.

13. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law

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

13.1 Utility

This document records the results of an interagency consultation. The information presented in this document is useful to the federal government 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

- ***Information Product Category:*** Natural Resource Plan.
- ***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

ABR 2016. Protected Species monitoring at the Kodiak Ferry terminal and dock improvements

project, Kodiak, Alaska, 2015-2016. 51+p.
ADFG. 2014. Alaska Department of Fish and Game. Ice Seal Research: Movements and habitat use studies. Division of Wildlife Conservation. available from http://www.adfg.alaska.gov/index.cfm?adfg=marinemammalprogram.icesealmovements. (viewed April 18, 2020).
Allen, B. M., and R. P. Angliss. 2014. Alaska marine mammal stock assessments, 2013. U.S. Dep. Commer., NOAA Tech. Memo. NMFSAFSC-277.
Anderson, J. J. 2000. A vitality-based model relating stressors and environmental properties to organism survival. Ecological Monographs 70:445-470.
Atkinson, S. 1997. Reproduction biology of seals. Reviews of Reproduction 2:175-194.
Atkinson, S., Crocker, D., Houser, D. et al. 2015. Stress physiology in marine mammals: how well do they fit the terrestrial model?. J Comp Physiol B 185: 463–486. https://doi.org/10.1007/s00360-015-0901-0
Audubon. 2010. Arctic Marine Synthesis. Atlas of the Chukchi and Beaufort Seas. Audubon Alaska. Anchorage, AK. First Edition. January 2010. Accessed September 2019 from https://ak.audubon.org/conservation/arcticmarine-synthesis-atlas-chukchi-and-beaufort-seas
Bates, N.R. J.T. Mathis, L.W. Cooper. 2009. Ocean acidification and biologically induces seasonality of carbonate mineral saturation states in the western Arctic Ocean. J. Geophys. Res. 114, C11007, doi:10.1029/2008JC004862.
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. USDOC, NOAA, NMFS, and USDOC, 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.
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.
BOEM. 2015a. Biological Assessment for Oil and Gas Activities Associated with Lease Sale 193. Page 312, Anchorage, AK.
BOEM. 2015b. Final Second Supplemental Environmental Impact Statement. Alaska Outer Continental Shelf Chukchi Sea Planning Area. Oil and Gas Lease Sale 193 in the Chukchi Sea, Alaska.
Boveng, P. L., and M. F. Cameron. 2013. Pinniped movements and foraging: Seasonal movements, habitat selection, foraging and haul-out behavior of adult bearded seals in the Chukchi Sea. U.S. Department of Interior, Bureau of Ocean Energy Management, Alaska Outer Continental Shelf Region, Environmental Studies Section, Anchorage, Alaska.
Boveng, P. L., M. Cameron, P. B. Conn, and E. Moreland. 2017. Abundance Estimates of Ice-Associated Seals: Bering Sea Populations that Inhabit the Chukchi Sea During the Open-Water Period. . BOEM Report 2016-077.
Braham, H. W., Burns, J. J., Gennadii, A. F., & Krogman, B. D. 1984b. Habitat Partitioning by Ice-Associated Pinnipeds: Distribution and Density of Seals and Walruses in the Bering Sea, April 1976. Soviet-American Cooperative Research on Marine Mammals, Volume 1-Pinnipeds, 25–47. Retrieved from https://repository.library.noaa.gov/view/noaa/5600

Brandon, J., and P. Wade. 2006a. Assessment of the Bering-Chukchi-Beaufort Seas stock of bowhead whales using Bayesian model averaging. Journal of cetacean research and management 8:225.

Brandon, R. 1978. Adaptation and evolutionary theory. Studies in the History and Philosophy of Science 9:181-206.

Brewer, P. G., and K. Hester. 2009. Ocean acidification and the increasing transparency of the ocean to low-frequency sound. Oceanography 22:86-93.

Broadwater, M.H., F.M. Van Dolah, and S.E. Fire. 2018. Vulnerabilities of Marine Mammals to Harmful Algal Blooms. pp 191-220 in Harmful Algal Blooms: A Compendium Desk Reference.Ed. SE Shumway, J.M. Burkholder, and SLMorton. First Edition. John Wiley and Sons.

Budelsky, R. A. 1992. Underwater behavior and vocalizations of the bearded seal (Erignathus barbatus) off Point Barrow, Alaska. Dissertation. University of Minnesota, Minneapolis, MN.

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

Burgess, W.C., S.B. Blackwell, and R. Abbott. 2005. 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.

Burns, J. J. 1967. The Pacific bearded seal. 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. 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. Annual Reports from Principal Investigators. April 1976. Volume 1 Marine Mammals. 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.77.

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

CNRC. Canada National Research Council. 1965. The ecology of the reproduction of seals in the northern part of the Sea of Okhotsk. Izvestiya TINRO. 59:212–216. Translation series (Canada. Fisheries and Marine Service), 1975. Accessed September 2019 via https://waves-vagues.dfo-mpo.gc.ca/Library/112264.pdf.

California Department of Transportation (Caltrans). 2015. Buehler, D., R. Oestman, J. Reyff, K. Pommerenck, B. Mitchell. 2015. Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. Written for the California Dept. of Transportation, Div. of Environmental Analysis, Environmental Engineering, Hazardous Waste, Air, Noise, Paleontology Office. Sacramento, CA.

Cameron, M. F. 2005. Habitat use and seasonal movements of bearded seals in Kotzebue Sound, Alaska. Alaska Fisheries Science Center Quarterly Research Report October-November-December 2004:18.

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. Alaska Fisheries Science

Center Quarterly Report, April-May-June 2007:12-14.

Cameron, M., and P. Boveng. 2009. Habitat use and seasonal movements of adult and sub-adult bearded seals. Alaska Fisheries Science Center Quarterly Report October-November-December 2009:1-4.

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). U.S. Department of Commerce, Seattle, WA.

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

Clark, D. C. Pfeiffer, and D.F. Cowan. 2005. Morphology and histology of the Atlantic bottlenose dolphin (Tursiops truncatus) adrenal gland with emphasis on the medulla. Anatomy, Histology, Embryology. 34:132-140

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.

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.

Crawford, J. A., K. J. Frost, 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.

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

Dehn, L.-A., G. G. Sheffield, E. H. Follmann, L. K. Duffy, D. L. Thomas, G. R. Bratton, R. J. Taylor, and T. M. O'Hara. 2005. Trace elements in tissues of phocid seals harvested in the Alaskan and Canadian Arctic: Influence of age and feeding ecology. Canadian Journal of Zoology 83:726-746.

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

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.

Dietz R., C. Sonne, N. Basu, B. Braune, T. O'Hara et al., 2013. What are the toxicological effects of mercury in Arctic biota? Sci. Total Environ. 443: 775–790.

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

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, Marley S.A., Schoeman R.P., Smith J.N., Trigg L.E. and Embling C.B. 2019. The Effects of Ship Noise on Marine Mammals—A Review. Front. Mar. Sci. 6:606. doi: 10.3389/fmars.2019.00606

Everitt, R., C. Fiscus, and R. DeLong. 1980. Northern Puget Sound marine mammals.

Interagency Energy. Environment R & D Program Report, US EPA, EPA-600/7-80-139. US EPA, Washington, DC.

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

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.

Fair PA, Schaefer AM, Houser DS, Bossart GD, Romano TA, Champagne CD, et al. (2017) The environment as a driver of immune and endocrine responses in dolphins (Tursiops truncatus). PLoS ONE 12(5): e0176202. https:// doi.org/10.1371/journal.pone.0176202

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.

Federal Register Notice. 2020. RTID 0648-XXXX. Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to the Crowley Kotzebue Dock Upgrade Project in Kotzebue, Alaska.

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. 16:362-366.

Fedoseev, G. A. 1971. The distribution and numbers of seals on whelping and moulting patches in the Sea of Okhotsk. Pages 87-99 in K. K. Chapskii and E. S. Milchenko, editors. Research on Marine Mammals. Atlantic Research Institute of Marine Fisheries and Oceanography (AtlantNIRO), Kaliningrad, Russia.

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..

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

Ferguson, S. H., B. G. Young, D. J. Yurkowski, R. Anderson, C. Willing and O. Nielsen. 2017. Demographic, ecological, and physiological responses of ringed seals to an abrupt decline in sea ice availability. PeerJ 5:e2957; DOI 10.7717/peerj.2957

Fey, S.B., A.M. Siepielski, S. Nussle, 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 animl mass mortality events. Proceedings of the National Academy of Sciences. 112:1083-1088.

Finley, K. J., and W. E. Renaud. 1980. Marine mammals inhabiting the Baffin Bay North Water in winter. Arctic 33:724-738.

Finneran, J.J., D.A. Carder, C.E. Schlundt, and S.H. Ridgeway. 2005. Temporary threshold shift (TTS) in bottlenose dophins (Tursiops truncatus) exposed to mid-frequency tones. Journal of the Acoustical Society of America, 118:2696-2705.

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

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.

Frid, A., and L. M. Dill. 2002. Human-caused disturbance stimuli as a form of predation risk. Conservation Ecology 6:1-16.

Frost, K. J. 1985. The ringed seal (Phoca hispida). Pages 79-87 in J. J. Burns, K. J. Frost, and L.

F. Lowry, editors. Marine Mammals Species Accounts. Alaska Department Fish and Game, Juneau, AK.

Frost, K. J., and L. Lowry. 1981. Ringed, Baikal and Caspian seals -- Phoca hispida Schrebner, 1775 Phoca sibrinica Gmelin, 1758 and Phoca caspica Gmelin, 1788. Pages 29-53 in S. H. Ridgeway and R. J. Harrison, editors. Handbook of Marine Mammals Volume 2: Seals. Academic Press, New York.

Frost, K. J., L. F. Lowry, G. Pendleton, and H. R. Nute. 2004. Factors affecting the observed densities of ringed seals, Phoca hispida, in the Alaskan Beaufort Sea, 1996-99. Arctic 57:115-128.

Frost, K. J., and L. F. Lowry. 1984. Trophic relationships of vertebrate consumers in the Alaskan Beaufort Sea.in P. W. Barnes, D. M. Schell, and E. Reimnitz, editors. The Alaskan Beaufort Sea: Ecosystemsand Environments. Academic Press, Inc., New York.

Frost, K. J., A. Whiting, M. F. Cameron, and M. A. Simpkins. 2008. Habitat use, seasonal movements and stock structure of bearded seals in Kotzebue Sound, Alaska. Tribal Wildlife Grants Program, Fish and Wildlife Service, Achorage, AK.

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.

Geyer,R., J.R. Jambeck,and K.L. Law. 2017. Production, use, and fate of all plastics ever made. Science Advances. 3:1-5.

Gjertz, I., K. M. Kovacs, C. Lydersen, and O. Wiig. 2000a. Movements and diving of adult ringed seals (Phoca hispida) in Svalbard. Polar Biology 23:651-656.

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

Gordon, J., D. Gillespie, J. Potter, A. Frantzis, M. P. Simmonds, R. Swift, and D. Thompson. 2003. A review of the effects of seismic surveys on marine mammals. Marine Technology Society Journal 37:16-34.

Gordon, J., D. Thompson, D. Gillespie, M. Longergan, S. Calderan, B. Jaffey, and V. Todd. 2007. Assessment of the potential for acoustic deterrents to mitigate the impact on marine mammals of underwater noise arising from the construction of offshore windfarms. Commissioned by COWRIE Ltd (project reference DETER-01-07).

Götz, T., and V. M. Janik. 2011. Repeated elicitation of the acoustic startle reflex leads to sensation in subsequent avoidance behaviour and induces fear conditioning. BMC Neuroscience 12:13

Greene, C. R., and S. E. Moore. 1995. Man-made noise. Pages 101-158 in W. J. Richardson, C. R. Greene, C. I. Malme, and D. H. Thomson, editors. Marine Mammals and Noise. Academic Press, Inc., San Diego, California.

Harwood, L. A., T. G. Smith, and J. C. Auld. 2012. Fall migration of ringed seals (Phoca hispida) through the Beaufort and Chukchi seas, 2001-02. Arctic 65:35-44.

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.
Harris, R. E., G. W. Miller, and W. J. Richardson. 2001. Seal responses to airgun sounds during summer seismic surveys in the Alaskan Beaufort Sea. Marine Mammal Science 17:795-812.
Helker, V. T., B. M. Allen, and L. A. Jemison. 2015. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2009-2013. National Marine Mammal Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.
Heptner, L. V. G., K. K. Chapskii, V. A. Arsenev, and V. T. Sokolov. 1976a. 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. Volume II, Part 3--Pinnipeds and Toothed Whales, Pinnipedia and Odontoceti. Vysshaya Shkola Publishers, Moscow, Russia.
Heptner, L. V. G., K. K. Chapskii, V. A. Arsenev, and V. T. Sokolov. 1976b. Ringed seal. Phoca (Pusa) hispida Schreber, 1775. Pages 218-260 in L. V. G. Heptner, N. P. Naumov, and J. Mead, editors. Mammals of the Soviet Union. Volume II, Part 3--Pinnipeds and Toothed Whales, Pinnipedia and Odontoceti. Vysshaya Shkola Publishers, Moscow, Russia.
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:L17505.
Holland, M. M., C. M. Bitz, and B. Tremblay. 2006. Future abrupt reductions in the summer Arctic sea ice. Geophysical Research Letters 33:L23503.
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.
Holsvik, R. 1998. Maternal behaviour and early behavioural ontogeny of bearded seals (Erignathus barbatus) from Svalbard, Norway. Masters Thesis. Norwegian University of Science and Technology, Trondheim, Norway.
Houghton, J. 2001. The science of global warming. Interdisciplinary Science Reviews 26:247-257.
Huntington, H. P., and C. Sookiayak. 2000. Traditional ecological knowledge of seals in Norton Bay, Alaska. Elim-Shaktoolik-Koyuk Marine Mammal Commission.
Huntington, H.P., L. T. Quakenbush, and N. Mark. 2016. Effects of changing sea ice on marine mammals and subsistence hunters in northern Alaska from traditional knowledge interviews. Biology Letters, Vol. 12, Issue 8. Report and supplemental materials accessed August 2019 via http://doi.org/10.1098/rsbl.2016.0198
Huntington, H.P., L. T. Quakenbush, and N. Mark. 2016b. Traditional Knowledge Regarding Ringed Seals, Bearded Seals, and Walrus near Kotzebue, Alaska. Final report to the Eskimo Walrus Commission, the Ice Seal Committee, and the Bureau of Ocean Energy Management for contract #M13PC00015. July 2016. Accessed September 2019 via https://www.adfg.alaska.gov/static/research/programs/marinemammals/pdfs/2016_traditional_knowledge_kotzebue.pdf
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. 2016. The subsistence harvest of ice seals in Alaska – a compilation of

existing information, 1960-2014.
Ice Seal Committee. 2017. The subsistence harvest of ice seals in Alaska – a compilation of existing information, 1960-2015.
IPCC. 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. New York, NY.
IPCC. 2014. Summary for Policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, Chapter 1 Framing and Context of the Report 1 1 122 M.P.R. and L.L. White (eds.)]. Cambridge Univ
IPCC, 2019: Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [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, N. Weyer (eds.)].
Isaac. 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, K.L. Law. 2015. Plastic waste inputs from land into the ocean. Science. 347:768-771.
Jiang, L.-Q., Feely, R. A., Carter, B. R., Greeley, D. J., Gledhill, D. K., and Arzayus, K. M. 2015. Climatological distribution of aragonite saturation state in the global oceans, Global Biogeochem. Cycles 29: 1656– 1673, doi:10.1002/2015GB005198
Jones, J. M., B. J. Thayre, E. H. Roth, M. Mahoney, I. Sia , et al. 2014. Ringed, Bearded, and Ribbon Seal Vocalizations North of Barrow, Alaska: Seasonal Presence and Relationship with Sea Ice. Arctic 67: 203-222.
Kastak, D., R.J. Schusterman, B.L. Southall, and C.J. Reichmuth. 1999. Underwater temporary threshold shift induced by octave-band noise in three species of pinniped. Journal of the Acoustical Society of America, 106(1142-1148).
Kelly, B. P. (1988a). Bearded seal, Erignathus barbatus. Washington, D.C.: Marine Mammal Commission.
Kelly, B. P. (1988b). Locating and characterizing ringed seal lairs and breathing holes in coordination with surveys using forward looking infra-red sensors Fisheries and Oceans Freshwater Institute Final Report. p. 17.
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). U.S. Department of Commerce, Seattle, WA.
Kelly, B. P., J. J. Burns, and L. T. Quakenbush. 1988. Responses of ringed seals (Phoca hispida) to noise disturbance. Pages 27-38 in W. M. Sackinger, M. O. Jeffries, J. L. Imm, and S. D. Treacy, editors. Port and Ocean Engineering Under Arctic Conditions, Volume II, Symposium on Noise and Marine Mammals, 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.

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.

Krylov, V. I., G. A. Fedoseev, and A. P. Shustov. 1964. Pinnipeds of the far east. Pischevaya Promyshlennost, Moscow, Russia.

Kumlien, L. 1879. Mammals. Pages 55-61 in Contributions to the Natural History of Arctic America made in connection with the Howgate Polar Expedition 1877-78. Government Printing Office, Washington, D.C

Kvadsheim P., E.M. Sevaldsen, L. P. Folkow, and A. S. Blix. Behavioural and Physiological Responses of Hooded Seals (Cystophora cristata) to 1 to 7 kHz Sonar Signals. Aquatic Mammals 2010, 36(3), 239-247

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.

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.

Laughlin, J. 2010. Airborne Noise Measurements (A-weighted and un-weighted) during Vibratory Pile Installation - Technical Memorandum. Prepared for Washington State Department of Transportation. 10 pp.

Law, A.L. 2017. Plastics in the marine environment. Annual Review of Mar. Sci. 9:205-229

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.

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.

Loganathan, B.G. and Kannan, K. 1994. Global Organochlorine Contamination Trends: An Overview. Ambio,23(3), 187-191. Retrieved April 19, 2020, from www.jstor.org/stable/4314197

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.

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

Lydersen, C. 1995. Energetics of pregnancy, lactation and neonatal development in ringed seals (Phoca hispida). Pages 319-327 in A. S. Blix, L. Wallae, and O. Ulltang, editors. Whales, Seals, Fish and Man. Elsevier Science, Amsterdam.

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. 1998. Status and biology of ringed seals (Phoca hispida) in Svalbard. Pages 46-62 in M. P. Heide-Jørgensen and C. Lydersen, editors. Ringed Seals in the North Atlantic. NAMMCO Scientific Publications, Volume 1, Tromsø, Norway
Lydersen, C., M. O. Hammill, and K. M. Kovacs. 1994a. Activity of lactating ice-breeding grey seals, Halichoerus grypus, from the Gulf of St. Lawrence, Canada. Animal Behaviour 48:1417-1425.
Lydersen, C., M. O. Hammill, and K. M. Kovacs. 1994b. Diving activity in nursing bearded seal (Erignathus barbatus) pups. Canadian Journal of Zoology 72:96-103.
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., K. M. Kovacs, M. O. Hammill, and I. Gjertz. 1996. Energy intake and utilisation by nursing bearded seal (Erignathus barbatus) pups from Salbard, Norway. Journal of Comparative Physiology B Biochemical Systemic and Environmental Physiology 166:405-411.
Lydersen, C., and M. S. Ryg. 1990. An evaluation of Tempelfjorden and Sassenfjorden as breeding habitat for ringed seals Phoca hispida. Pages 33-40 in T. Severinsen and R. Hansson, editors. Environmental Atlas Gipsdalen, Svalbard. Vol. III: Reports on the Fauna of Gipsdalen. Norsk Polarinstitutt Rapportserie, No.66
Lydersen, C., and T. G. Smith. 1989. Avian predation on ringed seal Phoca hispida pups. Polar Biology 9:489-490.
MacGillivray, A., G. Warner, and C. McPherson. 2015. Alaska DOT Hydroacoustic Pile Driving Noise Study: Kake Monitoring Results.
MacIntyre, K. Q., K. M. Stafford, C. L. Berchok, and P. L. Boveng. 2013. Year-round acoustic detection of bearded seals (Erignathus barbatus) in the Beaufort Sea relative to changing environmental conditions, 2008–2010. Polar Biology 36:1161-1173.
MacIntyre, K. Q., K. M. Stafford, P. B. Conn, K. L. Laidre, and P. L. Boveng. 2015. The relationship between sea ice concentration and the spatio-temporal distribution of vocalizing bearded seals (Erignathus barbatus) in the Bering, Chukchi, and Beaufort Seas from 2008 to 2011. Progress in Oceanography 136:241-249.
Mahoney, B. 2019. Marine Mammal Unusual Mortality Event Initiation Protocol. Issued July 2019.
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). Anatomical Record Part A-Discoveries in Molecular Cellular and Evolutionary Biology 288A:13-25.
McCabe, R.M., B. M. Hickey, R. M. Kudela, K. A. Lefebvre, N. G. Adams, B. D. Bill, F. M. D. Gulland, R. E. Thomson, W. P. Cochlan, and V. L. Trainer. 2016. An unprecedented coastwide toxic algal bloom linked to anomalous ocean conditions, Geophys. Res. Lett., 43:10,366–10,376. doi:10.1002/2016GL070023.
McCarthy, J. J. 2001. Climate change 2001: impacts, adaptation, and vulnerability: contribution of Working Group II to the third assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

McKinney, A.A., S. Pedro, R. Dietz, C. Sonne, A.T. Fisk, D. Roy, B.M. Jenssen, R. Letcher. 2015. Ar review of ecological impacts of global climate change on persistent organic pollutant and mercury pathways and exposures in Arctic marine ecosystems. Current Zoology. 61:617-628.

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

Mikkelsen, L., Johnson, M., Wisniewska, D. M., van Neer, A., Siebert, U., Madsen, P. T., et al. (2019). Long-term sound and movement recording tags to study natural behavior and reaction to ship noise of seals. Ecol. Evol. 9, 2588–2601. doi: 10.1002/ece3.4923

Miksis, J.L. and L.E. Madden. 2014. Environmental predictors of ice seal presence in the Bering Sea. PLoS. 9(9):e106998

Moore, S. E., and H. P. Huntington. 2008. Arctic marine mammals and climate change: impacts and resilience. Ecological Applications 18:S157-S165.

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. Alaska Fisheries Science Center Quarterly Report (July-AugustSeptember 2013):1-6.

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. Mizorch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. 2017. Alaska Marine Mammal Stock Assessments, 2016. Page 366 in N. U.S. Department of Commerce, editor.

Muto, M.M.,V.T. Helker, B.J. Delean, R. P. Angliss, P. L. Boveng, J.M. Breiwick, B.M. Brost, M. F. Cameron et al. 2019. Alaska Marine Stock Assessments. Marine Mammal Laboratory Alaska Fisheries Science Center.

Moulton, V. D., and J. W. Lawson. 2002. Seals, 2001.in W. J. Richardson, editor. Marine mammal and acoustical monitoring of WesternGeco’s open water seismic program in the Alaskan Beaufort Sea, 2001. LGL, Inc.

NAB. 2016. Iñuuniałiqput iḷiḷugu nunaŋŋuanun (Documenting our way of life through maps): Northwest Arctic Borough subsistence mapping project. GIS dataset used by permission. Accessed August 2019 from https://www.nwabor.org/subsistence-mapping-program/digital-atlas/

Nelson, R. K. 1982. Harvest of the sea: coastal subsistence in modern Wainwright, a report for the North Slope Borough's Coastal Management Program. North Slope Borough.

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.

Nelson, A.A., L.T. Quakenbush, B.D. Taras, Ice Seal Committee. 2019. Subsistence harvest of ringed, bearded, spotted, and ribbon seals in Alaska is sustainable. Endangered Species Research. 14:1-6. doi.org/10.3354/esr00973

NMFS. 2013. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion on Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska. National Marine Fisheries Service, Alaska Regional Office, Juneau, Alaska.

NMFS. 2015a. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Section 7(a)(4) Conference Report on Lease Sale 193 Oil and Gas Exploration Activities in the

U.S. Chukchi Sea, Alaska. Issued June 4, 2016. Page 342.

NMFS. 2015b. Revised exposure estimates for proposed SAE 3D seismic survey in nearshore Beaufort Sea 2015 open-water season. Incorporating daily ensonified area, percentage of habitat use, turnover rate, and percentage of airgun usage. Email from Shane Guan (PR1) to Alicia Bishop (AKR). Received June 10, 2015.

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 2019a. Ice Seal Stranding Data Tables. 2019.

NOAA. 2015. Draft guidance for assessing the effects of anthropogenic sound on marine mammal hearing: underwater acoustic threshold levels for onset of permanent and temporary threshold shifts. National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

NOAA National Centers for Environmental Information, State of the Climate: Global Climate Report for Annual 2019, published online January 2020, retrieved on February 17, 2020 from https://www.ncdc.noaa.gov/sotc/global/201913.

NOAA 2019b. Alaska Fisheries Science Center. 2019. Presented at the October 29, 2019 Alaska Eskimo Whaling Commission meeting.

NOAA. 2020. Final List of Fisheries. Federal Register Notice. 50 CFR Part 229. April 16, 2020. Vol 85 no. 74:21079-21103.

Nordon. 2014. Marine Invasive Species in the Arctic. Nordic Council of Ministers. TemaNord 2014:547.

Nowacek, D.P., L.H. Thorne, D.W. Johnston, and P.L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. Mammal Review 37:81-115.

NRC (Nation Research Council). 2003. Ocean Noise and Marine Mammals. Ocean Study Board, National Academy Press, Washington, DC.

NSIDC. 2016. The Arctic set yet another record low maximum extent. National Snow and Ice Data Center. Arctic Sea Ice News and Analysis. Accessed April 28, 2016. https://nsidc.org/news/newsroom/arctic-sets-yet-another-record-low-maximum-extent

NSIDC. 2019. Monthly Archives. 2019. http://nsidc.org/arcticseaicenews/2019/10/

Ognev, S. I. 1935. Mammals of U.S.S.R. and adjacent countries. Volume 3. Carnivora. Glavpushnina NKVT, Moscow, Russia..

Oreskes, N. 2004. The scientific consensus on climate change. Science 306:1686-1686.

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., and M. Y. Wang. 2007. Future regional Arctic sea ice declines. Geophysical Research Letters 34:L17705.

Pachauri, R. K., and A. Reisinger. 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Intergovernmental Panel on Climate Change 1.

Parry, M. L. 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability: Working Group II Contribution to the Fourth Assessment Report of the IPCC Intergovernmental Panel on Climate Change. Cambridge University Press.

Peeken,I., S. Primpke, B. Beyer, J. Gutermann, C. Katlein, T. Krumpen, M. Bergmann, L. Hehemann, and G. Gerdts. 2018. Arctic sea ice is an imprtant temporal sink and means of transport for microplastic. Nature Communications. 9:1-12.

PND Engineers, Inc. 2016. Request for an Incidental Harassment Authorization Under the Marine Mammal Protection Act for the Unalaska Marine Center Dock Positions III and IV Replacement Project. Revised Sept. 30, 2016.

PND Engineeers. 2020. Environmental Baseline, Biological Resource Assessment, and Essential Fish Habitat Report. Crowley Kotzebue Dock Upgrade Kotzebue, Alaska February 2020. Prepared For: Crowley Fuels, LLC. PND Engineers, Inc. Anchorage, AK

Qi, D., L. Chen, B. Chen, Z. Gao, W. Zhong, R. A. Feely, L. 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 7:195-201. DOI: 10.1038/NCLIMATE3228

Quakenbush, L., J. Citta, and J. Crawford. 2011a. Biology of the ringed seal (Phoca hispida) in Alaska, 1960-2010. Final Report to: National Marine Fisheries Service.

Quakenbush, L., J. Citta, and J. Crawford. 2011b. Biology of the bearded seal (Erignathus barbatus) in Alaska, 1961-2009. Final Report to: National Marine Fisheries Service.

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. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Alaska Outer Continental Shelf Region, Anchorage, AK.

OCS Study BOEM 2019-079. 131 pp + appendices.

Ray, C., W. A. Watkins, and J. J. Burns. 1969. The underwater song of Erignathus (bearded seal). Zoologica 54:79-83, +73pls.

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.

Reeves, R. R., B. S. Stewart, and S. Leatherwood. 1992. Bearded seal, Erignathus barbatus Erxleben, 1777. Pages 180-187 The Sierra Club Handbook of Seals and Sirenians. Sierra Club Books, San Francisco, CA.

Reisdorph, S.S. and J.T. Mathis. 2014. The dynamic controls on carbonate mineral saturation states and ocean acidification in a glacially dominated esturary. Estuarine, Coastal and Shelf Science. 144:8-18

Rice, D. W. 1998. Marine mammals of the world: Systematics and distribution. The Society for Marine Mammology, Lawrence, Kansas.

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.

Riewe, R. R., and C. W. Amsden. 1979. Harvesting and utilization of pinnipeds by lnuit hunters in Canada's eastern High Arctic. Pages 324-348 in A. P. McCartney, editor. Thule Eskimo Culture: An Anthropological Retrospective. Mercury Series 88. Archaeological Survey of Canada, Ottawa, Canada.

Risch, D., C. W. Clark, P. J. Corkeron, A. Elepfandt, K. M. Kovacs, C. Lydersen, I. Stirling, and S. M. V. Parijs. 2007. Vocalizations of male bearded seals, Erignathus barbatus: Classification and geographical variation. Animal Behaviour 73:747-762.

Rolland, R. M., S. E. Parks, K. E. Hunt, M. Castellote, P. J. Corkeron, D. P. Nowacek, S. K. Wasser, and S. D. Kraus. 2012. Evidence that ship noise increases stress in right whales.

Proceedings of the Royal Society of London B: Biological Sciences 279:2363-2368.

Romano, T. A., M. J. Keogh, C. Kelly, P. Feng, L. Berk, C. R. Schlundt, D. A. Carder, and J. J. Finneran. 2004. Anthropogenic sound and marine mammal health: Measures of the nervous and immune systems before and after intense sound exposure. Canadian Journal of Fisheries and Aquatic Sciences 61:1124-1134.

Rosen, D. A. S., and Kumagai, S. 2008. Hormone changes indicate that winter is a critical period for food shortages in Steller sea lions. Journal of Comparative Physiology B, 178, 573–583.

Savage, K. 2019. Stranding Report for 2019. September 14-30, 2019.

Scheffer, V. B. 1958. Seals, sea lions and walruses: a review of the Pinnipedia. Stanford University Press, Palo Alto, CA.

Schlundt, C.E., J.J. Finneran, D.A. Carder, and S.H. Ridgway. 2000. Temporary shift in masked hearing thresholds of bottlenose dolphins, Tursiops truncatus, and white whales, Delphinapterus leucas, after exposure to intense tones. Journal of the Acoustical Society of America 107:3496-3508.

Scholin, C.A., Gulland, F., Doucette, G.J., Benson, S., Busman, M., Chavez, F.P., Cordaro, J., DeLong, R., De Vogelaere, A., Harvey, J., Haulena, M., Lefebvre, K., Lipscomb, T., Loscutoff, S., Lowenstine, L.J., Marin, R., 3rd, Miller, P.E., McLellan, W.A., Moeller, P.D., Powell, C.L., Rowles, T., Silvagni, P., Silver, M., Spraker, T., Trainer, V., Van Dolah, F.M. 2000. Mortality of sea lions along the central California coast linked to a toxic diatom bloom. Nature 403:80–84.

Silber GK and Adams JD (2019) Vessel Operations in the Arctic, 2015–2017. Front. Mar. Sci. 6:573. doi: 10.3389/fmars.2019.00573

Sills, J.M.,B.L. Southall, and C. Reichmuth. 2015. Amphibious hearing in ringed seals (Pusa hispida): underwater audiograms, aerial audiograms and critical ratio measurements. The Journal of Experimental Biology. 218: 2250-2259.

Simmonds, M. P., and J. D. Hutchinson. 1996. The Conservation of Whales and Dolphins - Science and Practice. John Wiley & Sons.

Smith, T., G., and D. Taylor. 1977. Notes on marine mammals, fox and polar bear harvests in the Northwest Territories, 1940 to 1972. Arctic Biological Station, Fisheries and Marine Service, Department of Fisheries and the Environment, Quebec.

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. 1987. The ringed seal, Phoca hispida, of the Canadian western Arctic. 0660124637, Bulletin Fisheries Research Board of Canada, Ottawa, Canada.

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 M. O. Hammill. 1981. Ecology of the ringed seal, Phoca hispida, in its fast ice breeding habitat. Canadian Journal of Zoology 59:966-981.

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.

Sobeck. 2016. Revised Guidance for Treatment of Climate Change in NMFS Endangered Species Act Decisions. Memorandum for NMFS Assistant Administrator for Fisheries to NMFS Leadership Council, June 2016, 10 p.

Southall, B. L., A. E. Bowles, W. T. Ellison, J. J. Finneran, R. L. Gentry, C. R. Greene, Jr., D. Kastak, D. R. Ketten, J. H. Miller, P. E. Nachtigall, W. J. Richardson, J. A. Thomas, and P. L. Tyack. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. Aquatic Mammals 33:411-521.

Stearns, S. C. 1977. The evolution of life history traits: A critique of the theory and a review of the data. Annual Review of Ecology and Systematics 8:145-171.

Stearns, S. C. 1992a. The Evolution of Life Histories. Oxford Press, Oxford. 249.

Sternfeld, M. 2004. Ice Seals in the National Marine Fisheries Service Alaska Region (NMFS AKR) Stranding Records: 1982-2004. USDOC, NOAA, NMFS Alaska Region, Juneau, Alaska.

Stirling, I. 1973. Vocalization in the ringed seal (Phoca hispida). Journal of the Fisheries Research Board of Canada 30:1592-1594.

Stirling, I. 1983. The evolution of mating systems in pinnipeds. Pages 489-527 in J. F. Eisenberg and D. G. Kleiman, editors. Advances in the Study of Mammalian Behavior. Special Publications No. 7. The American Society of Mammalogists, Shippensburg, PA.

Stirling, I., W. Calvert, and H. Cleator. 1983. Underwater vocalizations as a tool for studying the distribution and relative abundance of wintering pinnipeds in the High Arctic. Arctic 36:262-274.

Stirling, I., and J. A. Thomas. 2003. Relationships between underwater vocalizations and mating systems in phocid seals. Aquatic Mammals 29:227-246.

Stocker, T. F., Q. Dahe, and G.-K. Plattner. 2013. Climate Change 2013: The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Summary for Policymakers (IPCC, 2013).

Swails, K. (2005) Patterns of seal strandings and human interactions in Cape Cod, MA. Master of Environmental Management Thesis. Duke University, Durham, NC, USA.

Tanabe, S., Iwata, H. and R. Tatsukawa. 1994. Global contamination by persistent organochlorines and their ecotoxicological impact on marine mammals. Science of the Total Environment 154:163-177 .

Thoman, R. & J. E. Walsh. (2019). Alaska's changing environment: documenting Alaska's physical and biological changes through observations. H. R. McFarland, Ed. International Arctic Research Center, University of Alaska Fairbanks.

URS Corporation. 2007. Port of Anchorage Marine Terminal Development Project, Underwater Noise Survey, Test Pile Driving Program. Prepared for United States Department of Transportation Maritime Administration. Available online at https://www.fisheries.noaa.gov/webdam/download/69425694

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.

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. NatureReseach. 9:15569 doi.org/10.1038/s41598-019-51699-4

Wartzok, D., R. Elsner, H. Stone, B. P. Kelly, R. W. Davis.1992. Under-ice movements and the sensory basis of hole finding by ringed and Weddell seals. Canadian Journal of Zoology. 70:1712-1722.

Watanabe, Y., C. Lydersen, K. Sato, Y. Naito, N. Miyazaki, and K. M. Kovacs. 2009. Diving behavior and swimming style of nursing bearded seal pups. Marine Ecology Progress Series 380:287-294.

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.

Wieting, D. 2016. Interim Guidance on the Endangered Species Act Term "Harass".in N. M. F. S. United States Department of Commerce, editor.

Wright, A. J., N. A. Soto, A. Baldwin, M. Bateson, C. Beale, C. Clark, T. Deak, E. Edwards, A. Fernandez, A. Godinho, L. Hatch, A. Kakuschke, D. Lusseau, D. Martineau, L. Romero, L. Weilgart, B. Wintle, G. Notarbartolo Di Sciara, and V. Martin. 2007. Anthropogenic noise as a stressor in animals: A multidisciplinary perspective. International Journal of Comparative Psychology 201:250-273.

Zarfl, C. and M. Matthies. 2010. Are marine plastic particles transport vectors for organic pollutants to the Arctic? Marine Pollution Bull. 60:1810-1814.

Zarnke, R. L. et al. Serologic survey for Brucella spp., phocid herpesvirus-1, phocid herpesvirus-2, and phocine distemper virus inharbor seals from Alaska, 1976–1999. 2006. Journal of Wildlife Diseases 42: 290–300.