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

Ice Exercise 2022

NMFS Consultation Number: AKRO-2021-02659

Action Agencies: U.S. Department of Navy
NMFS Office of Protected Resources, Permits, and Conservation Division

Affected Species and Determinations:

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

Consultation Conducted By: National Marine Fisheries Service, Alaska Region

Issued By:

Robert D. Mecum
Acting Regional Administrator

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Terms and Abbreviations

µPa	Micro Pascal
2D	Two-Dimensional
3D	Three-Dimensional
Ac	Acre
ADNR	Alaska Department of Natural Resources
AEWC	Alaska Eskimo Whaling Commission
AKR	Alaska Region
ARBO	Arctic Regional Biological Opinion
ASAMM	Aerial Surveys of Arctic Marine Mammals
ASL	Above Sea Level
BA	Biological Assessment
Bbbl	Billion Barrels
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CHIRP	Compressed High Intensity Radar Pulse
CSEL	Cumulative Sound Exposure Level
CWA	Clean Water Act
dB re 1µPa	Decibel referenced 1 microPascal
DPS	Distinct Population Segment
EEZ	Exclusive Economic Zone
EMATT	Expendable Mobile Anti-Submarine Warfare Training Targets
EPA	Environmental Protection Agency
ESA	Endangered Species Act
°F	Fahrenheit
FAA	Federal Aviation Administration
FR	Federal Register
ft	Feet
g	Gallons
G&G	Geological and Geophysical
Hz	Hertz
IHA	Incidental Harassment Authorization
IPCC	Intergovernmental Panel on Climate Change
ITA	Incidental Take Authorization
ITS	Incidental Take Statement
IWC	International Whaling Commission
kHz	Kilohertz

km	Kilometers
kn	Knots
L	Liter
m	Meter
mi	Mile
MMPA	Marine Mammal Protection Act
MRE	Meal Ready to Eat
ms	Milliseconds
μPa	Micro Pascal
NAEMO	Navy Acoustic Effects Model
NEPA	National Environmental Policy Act
nm	Nautical Mile
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NSB	North Slope Borough
NSF	National Science Foundation
NSR	Northern Sea Route
OCS	Outer Continental Shelf
Opinion	Biological Opinion
OSRA	Oil Spill Risk Analysis
Pa	Pascals
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyls
PTS	Permanent Threshold Shift
RMS	Root Mean Square
ROV	Remotely Operated Vehicle
RPA	Reasonable and Prudent Alternative
s	Second
SEL	Sound Exposure Level
SONAR	Sound Navigation And Ranging
TTS	Temporary Threshold Shift
UAS	Unmanned Aircraft System
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VLOS	Very Large Oil Spill

1. Introduction

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

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

In this document, the action agencies are the United States Navy (Navy) which proposes to conduct military exercises in the Arctic, and the NMFS Office of Protected Resources, Permits and Conservation Division (hereafter referred to as "the Permits Division") which plans to issue an incidental harassment authorization (IHA) pursuant to section 101(a)(5)(D) of the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1361 et seq.), to the Navy for harassment of marine mammals incidental to the proposed activities (86 FR 70451). When issued, the IHA will be valid from February 1, 2022 to April 30, 2022, and will authorize the incidental harassment of the threatened Arctic ringed seal. The consulting agency for this proposal is NMFS's Alaska Region (AKR). This document represents NMFS's biological opinion (opinion) on the effects of this proposal on endangered and threatened species and designated critical habitat.

The opinion and ITS were prepared by NMFS Alaska Region in accordance with section 7(b) of the ESA (16 U.S.C. § 1536(b)) and implementing regulations at 50 CFR part 402.

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

1.1. Background

This opinion is based on information provided in the October 2021 Biological Assessment for the project (Navy 2021a), the August 2021 Request for an Incidental Harassment Authorization, the October 2021 Environmental Assessment/Overseas Environmental Assessment for the Ice Exercise Program (Navy 2021b), clarifying emails between NMFS and Navy staff, stock assessment reports, monitoring reports, and relevant peer reviewed literature. A complete record of this consultation is on file at NMFS's Anchorage, Alaska office.

The proposed action involves the establishment of a temporary base camp on Arctic ice in the Beaufort Sea approximately 100–200 nautical miles north of Prudhoe Bay (Figure 1). The base camp would support submarine training and testing under Arctic conditions, test emerging technologies and their capabilities in the Arctic, and gather data on Arctic environmental conditions. The construction, use, and demobilization of the camp would occur over a six-week period from February to April 2022.

This opinion considers the effects of the Navy's Ice Exercise (ICEX 2022) in the winter/spring of 2022. These actions have the potential to affect the threatened Arctic subspecies of ringed seal (*Phoca hispida hispida*). Critical habitat has been proposed for ringed seal (86 FR 1452) but it is not expected to be finalized before this project has concluded. Bowhead whales were not included in the IHA application because they migrate to the west and south in the winter and will not be present in the action area. Likewise, bearded seals are not included in the IHA and are discussed below in section 4.1.

1.2. Consultation History

August 31, 2021: IHA application package received at Permits Division

October 5, 2021: AKR receives transmittal letter requesting initiation of consultation and the Biological Assessment (BA) for ICEX 2022.

October 11, 2021: Questions sent to Navy to clarify points in the BA.

October 12, 2021: Early Review Team meets for coordination between AKR and the Permits Division on the project.

October 14, 2021: Mitigation measures sent to Navy.

October 14, 2021: Response to questions about BA received from Navy

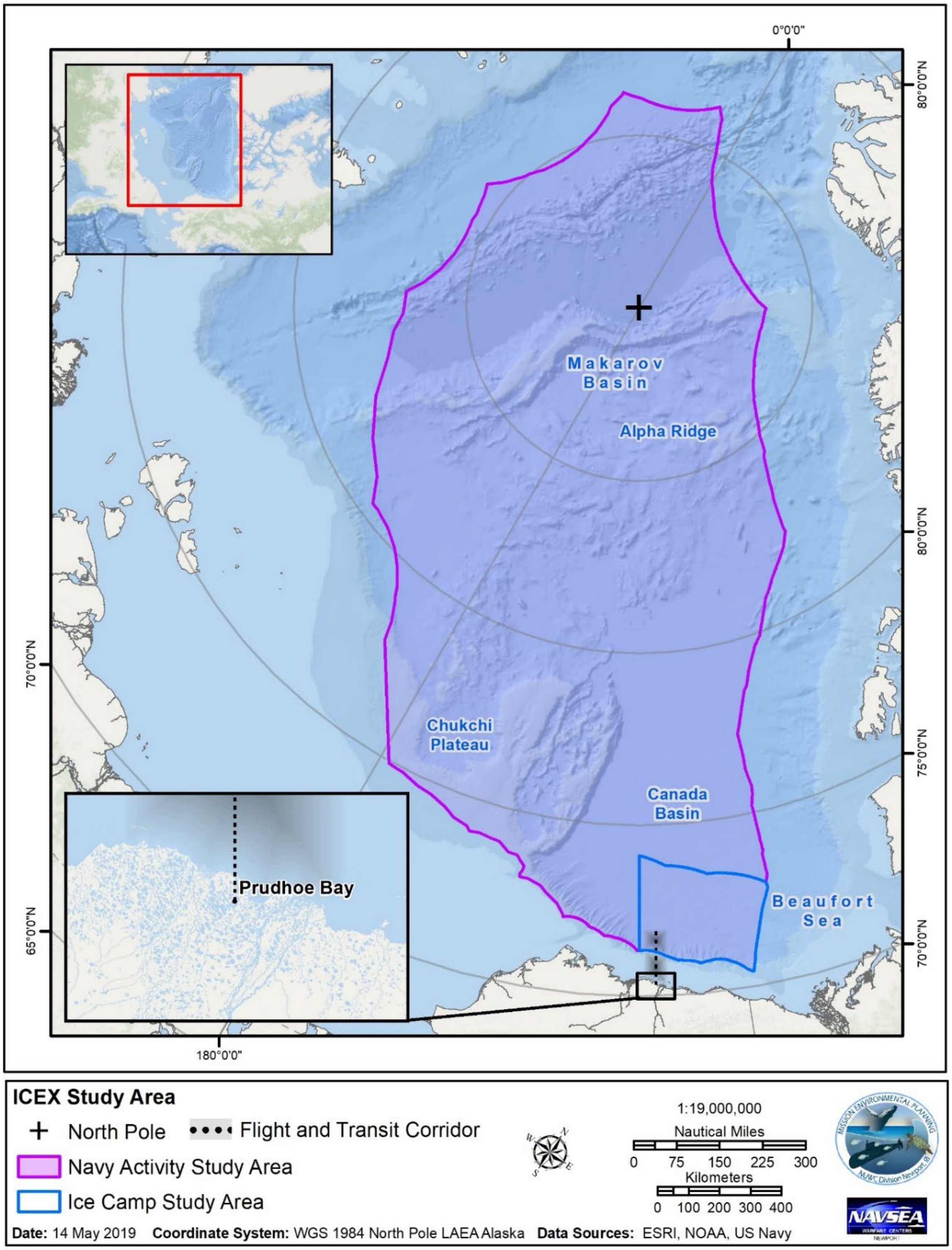
October 15, 2021: AKR receives the 2021 Environmental Assessment/Overseas Environmental Assessment for the Ice Exercise Program

October 29, 2021: AKR received confirmation of the implementation of mitigation measures.

November 3, 2021: Consultation initiated.

November 2021: Coordination and communication with the Permits Division and the Navy.

December 10, 2021: The proposed IHA was published in the Federal Register (86 FR 70451).


0°0'0"
80°0'0"N
Makarov Basin
Alpha Ridge
80°0'0"N
70°0'0"N
Chukchi Plateau
75°0'0"N
Canada Basin
Prudhoe Bay
Beaufort Sea
65°0'0"N
70°0'0"N
180°0'0"
ICEX Study Area
North Pole
Flight and Transit Corridor
Navy Activity Study Area
Ice Camp Study Area
1:19,000,000
Nautical Miles
0 75 150 225 300
Kilometers
0 100 200 300 400
Date: 14 May 2019 Coordinate System: WGS 1984 North Pole LAEA Alaska Data Sources: ESRI, NOAA, US Navy

2. Description of the Proposed Action and Action Area

2.1. Proposed Action

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

The purpose of the proposed action is to conduct submarine training and testing activities to evaluate the employment and tactics of submarine operability in Arctic conditions. The proposed action includes the establishment of a tracking range and temporary ice camp, conducting research in an Arctic environment, evaluating emerging technologies and assessing their capabilities in the Arctic environment, and gathering data on Arctic environmental conditions. The majority of submarine training and testing would occur near the ice camp; however, some submarine training and testing may occur throughout the deep Arctic Ocean basin near the North Pole, within the Navy Activity Study Area (Figure 1). The proposed action, including the construction and demobilization of an ice camp, would occur over approximately a six-week period, from February to the beginning of April. The submarine training and testing and the research activities, when occurring, would occur over approximately four weeks during the six-week period for ICEX events. The camp should be fully functional within five days once the initial cargo flights have dropped off equipment.

2.2. Proposed Activities

2.2.1. Ice Camp

Prior to the establishment of the ice camp, a suitable ice floe must be found. The ice floe must have the following characteristics: ice thicker than surrounding ice to reduce the risk of break-up (must be multi-year ice); large enough to support camp operations; surrounded by level ice suitable for a landing strip (first year ice); and located within 200 nautical miles (nm) of Deadhorse, Alaska. Floe selection begins in the office with the examination of satellite imagery to find floes that appear to meet the criteria. These floes are then checked through airborne reconnaissance. If a floe appears suitable from the air, a team of two lands to conduct on-ice surveys to determine ice thickness. This is done both by auguring cores and by dragging an electromagnetic device on the ice surface that can measure ice thickness.

The ice camp would consist of a command hut, dining tent, sleeping quarters, an outhouse, a powerhouse, a runway (and a back-up runway for use in case of emergency), and a helipad (Figure 2). The number of structures/tents would range from 15 to 20 and are typically 2 to 6 meters (m) by 6 to 10 m in size. Berthing tents would contain bunk beds, a heating unit, and a circulation fan. The completed ice camp, including runway, would be approximately 1.6 kilometers (km) in diameter. The proposed activities for training at the camp are listed in Table 1.

All ice camp materials, fuel, and food would be transported from Prudhoe Bay, Alaska, and delivered by air-drop from military transport aircraft (e.g., C-17 and C-130), or by landing at the ice camp runway. Aircraft would be used to transport personnel and equipment from the ice camp to Prudhoe Bay. At the completion of ICEX events, the ice camp would be demobilized, and all personnel and materials would be removed from the ice floe. All shelters, solid waste, hazardous waste, and sanitary waste would be removed and disposed of in accordance with applicable laws and regulations.

A portable tracking range for submarine training and testing would be installed in the vicinity of the ice camp during the exercises; hydrophones, located on the ice and extending to approximately 30 m below the ice, would be deployed. Hydrophones are approximately 11.8 centimeters (cm) in length and have 610 m in associated cables; nothing associated with the tracking range would extend more than 30 m below the ice. The associated cable is Kevlar reinforced and has a long-life polyurethane jacket for durability. The hydrophones would be deployed by drilling holes in the ice and lowering the cable down into the water column.

Freshwater would be generated at the camp via ice mining and by reverse osmosis desalination of sea water. Freshwater would only be made available in the camp's dining facility. This water would be available for food preparation, dishwashing, and human consumption. Additionally, a hygiene station would be available at the ice camp for hand/face washing. The hygiene station would utilize the same drain as the kitchen sink for grey water discharge. No shower facilities would be available at the camp.

Dishwashing and a hygiene station would use biodegradable, chlorine-, and phosphate-free detergent that meets the Environmental Protection Agency's Safer Choice standards (U.S. Environmental Protection Agency 2015). Prior to use, dishwashing water would be heated using an on-demand propane water heater. Wastewater generated during food preparation and dishwashing would be discharged to the Beaufort Sea via a single drain in the camp's dining facility. As pre-prepared Meals Ready to Eat (MREs) are going to be used, minimal waste from food preparation will occur. The drain would consist of a corrugated pipe wrapped in electric heat tape to prevent the pipe from freezing, which would be placed through a hole drilled/melted into the ice. The drain would utilize a removable metal screen to capture solid debris (i.e., food particles) in the wastewater prior to discharge. The metal screen would have a mesh size of no greater than 0.16 cm. Solids captured in the screen would be disposed of via the camp's solid waste containers and brought back to Prudhoe Bay, Alaska, for disposal. The camp would have an average discharge rate of 100 gallons per day, with a maximum discharge rate of 195 gallons per day during the two weeks of peak camp operations.

The operation of a reverse osmosis system results in "reject water," or water that is of higher salinity (approximately three times the salinity) than the initial seawater input. This reject water would also be discharged at the camp via a single drain (corrugated pipe placed through a hole in the ice) collocated with the portable system. The average reject water production is expected to be 144 gallons per day. This amount is based on the unit not being operated continuously due to downtime associated with system maintenance and adjustments for flow rate. The maximum reject water production would be approximately 576 gallons per day. The extreme conditions of the ice camp would influence both the system's efficiency and ability to operate, which is why the output from the system would be variable. Assuming continuous operation (24 hours per day) for the 4 weeks of camp operations (excluding a week each for construction and demobilization), a maximum total discharge of reject water from the ice camp would be 8,064 gallons.

Sanitary/human waste generated at the camp would be collected in zero-discharge sanitary facilities (e.g., barrels lined with a plastic bag), would be collected and containerized, then flown back to Prudhoe Bay, Alaska, for disposal at appropriate facilities.

In addition to the main ice camp, two smaller, adjacent berthing areas are proposed for ICEX events. These areas (used for expeditionary forces) would leverage the facilities provided by the main camp (e.g., sanitary facilities) while verifying these groups could function independently if necessary. All materials from these adjacent areas would be removed from the ice upon completion of the activities.

Figure 2. Ice camp.

2.2.2. On-ice vehicles

Snowmobiles would be used to transport personnel and equipment on the ice. Additionally, snowmobiles would support research activities that require data collection from multiple locations, with some at a distance from the ice camp. Four to six snowmobiles would be used. Two types of snowmobiles are typically used at the ice camp. Heavyweight snowmobiles have a single steering track and a very large drive track; these machines are slow with limited maneuverability and are used to pull sleds and sledges to move equipment around camp. Lightweight snowmobiles have dual steering tracks and a single drive track, are faster and maneuverable, and are used to transport personnel. In addition to the typical snowmobiles, two types of all-terrain tracked vehicles, one equipped with four wheels and one equipped with six or eight wheels, that can be used in open water (referenced herein as all-terrain tracked vehicle) (Figure 3) may be air-dropped to support runway construction and expeditionary forces.

The all-terrain tracked vehicles have a load capacity of up to 1,200 pounds, depending on the model. They are capable of floating in open water if necessary. All-terrain tracked vehicles have two engine types, typically gasoline engine or diesel. Both engines are approximately 30 horsepower (Ontario Drive and Gear Ltd. 2017). The all-terrain tracked vehicle would be used to transport expeditionary forces to and from the main camp.

Figure 3. All-terrain tracked vehicle.

2.2.3. Aircraft

Flights to and from Prudhoe Bay would utilize the public airport in Deadhorse, Alaska. Up to nine round trips could occur daily during ice camp build-up and demobilization; one to three round trips could occur daily during ice camp operations. All flights would leave from Deadhorse Airport and fly directly to the ice camp. During ICEX events when exercise torpedoes (i.e., non-explosive) are retrieved from the water column following submarine training and testing, they would be transported to and processed at Prudhoe Bay. Exercise torpedoes would then be prepared for transport in accordance with existing Navy policies.

Shelters, personnel, and equipment would be transported to and from the ice camp via various fixed-wing and rotary-wing aircraft. Up to nine round trips may be conducted each day during ice camp build-up and demobilization; one to three round trips may occur during ice camp operations. These aircraft also support many of the research activities. In addition to the typical commercial aircraft, military aircraft may be used depending on their availability. Examples of military aircraft that may be used include C-130, V-22 and C-17 transport aircraft (as well as the LC-130, which is a modified C-130 suited to land on the ice) and CH-47 Chinook heavy-lift helicopters (Figure 4). These aircraft are much larger than the small, fixed-wing aircraft typically used (up to 53 m in length for the C-17 compared to 8 and 24 m in length for a Cessna 185 and Casa, respectively) and would allow for more efficient (i.e., fewer trips) transport of supplies. Equipment and material may be dropped by parachute from these military aircraft. The LC-130 would conduct up to four round trip flights to the ice camp over the course of the Proposed Action; these are included within the maximum number of daily flights to the ice camp. The V-22 would only land and take off from the ice camp one time. The V-22 Osprey has several modes of operation associated with it, which include a vertical take-off, similar to a helicopter as well as a traditional take off similar to other fixed-wing aircraft. The V-22 generates a large amount of heat from its engines. However, due to the low ambient temperature of the Arctic, ice thickness required supporting aircraft and re-freezing of the ice, temporary melting of the runway may occur and re-freeze after the aircraft has departed the ice. The aircraft would not be allowed to alter the runway enough to make it inoperable for the remainder of the aircraft operations which would need to occur.

Figure 4. Examples of Military Fixed-Wing Aircraft (left panel; C-130) and Rotary-Wing Aircraft (right panel; CH-47) that may be Used During ICEX.

2.2.4. Submarine Training, Testing, and Torpedo Exercises

Submarine activities associated with ICEX events are classified, but generally entail safety maneuvers and active sonar use. These maneuvers and sonar use are similar to submarine activities conducted in other undersea environments; they are being conducted in the Arctic to test their performance in a cold environment. Submarine training and testing involves active acoustic transmissions, which have the potential to harass marine mammals. Details about torpedoes and torpedo firing are classified. Up to 20 torpedoes, likely fewer, will be launched during ICEX 2022. Torpedoes will be retrieved by divers. Holes 3 to 4 feet in diameter will be melted in the ice to provide divers access to the water.

2.2.5. Unmanned Vehicles and Systems

Unmanned underwater vehicles would either maneuver autonomously or may be tethered to a command center (Figure 5). Unmanned underwater vehicles are typically slow moving (less than 5 knots), and range in size from approximately 52 cm in length and width to 493 cm in length and 53 cm in diameter. Some unmanned underwater vehicles would have *de minimis* acoustic sources used and deployed throughout ICEX events. *De minimis* sources, as applied in these circumstances, have the following parameters: low source levels, narrow beams, downward directed transmission, short pulse lengths, frequencies above (outside) known marine mammal hearing ranges, or some combination of these factors (Department of the Navy 2013b).

In addition to unmanned underwater vehicles, various unmanned aerial systems are proposed for testing. Systems used may be either fixed-wing or rotary-wing. Fixed-wing systems vary in their wingspans, up to approximately 305 cm, and fly at speeds of about 80 knots. Rotary-wing systems are typically smaller, approximately 51 cm in length and width, and fly at speeds of about 30 knots.

2.2.6. Scientific Devices

Various passive and active acoustic devices would be used for data collection, including a vertical array and buoys.

Figure 5. Examples of Unmanned Underwater Vehicles. Top panel is a Remote Environmental Monitoring Unit System 100; bottom left is a 21” Bluefin; bottom center is a Little Benthic Vehicle (LBV) 300; bottom right is the tether associated with the LBV300, resulting in a Tethered, Hovering Autonomous Underwater System.

A vertical line array would be deployed through the ice to measure ambient underwater noise and sound propagation through the water. This array would contain a series of acoustic recorders located near the surface to a depth of 200 m.

Other scientific devices (typically less than 1 m in diameter) would be deployed throughout the ICEX events, including four EMATTS (Expendable Mobile Anti-Submarine Warfare Training Targets) which will transmit in specific patterns within the mixed arctic water layer, for the vertical line arrays to receive. EMATTS, which are approximately 36 inches in length and 5 inches in diameter, would scuttle and would not be retrieved. Because of their low source level EMATT sound emissions are *de minimis*. To support submarine self-tracking, an acoustic buoy would be deployed and would emit a homing signal so that the submarines can determine their location relative to the ice camp. This buoy would be retrieved at the completion of the exercise. The remaining devices would be deployed as part of the research activities and would collect data on the under-ice topography and environmental conditions.

Table 1. Summary of Training and Testing and Research Objectives for the Ice Exercise Program

Activity Type	Category of Action	Project	Description
Submarine Training and Testing	Logistics	Ice Camp Operations	A camp is constructed and an associated underwater tracking range is deployed to support submarine training and testing.
	Submarine Training and Testing	Submarine Training and Testing	Submarines conduct various training and testing events, including use of torpedoes

Activity Type	Category of Action	Project	Description
Research Activities	Aerial Data Collection	Aircraft	Use of manned aircraft and sensors to collect ice and snow thickness data and to validate/calibrate satellite measurements.
	In-water Device Data Collection	Buoy	Deployment of surface buoys through the ice to transmit signals to line array and support submarine tracking
		Array	Use of an acoustic array to collect data on ambient noise, as well as determine signal propagation through Arctic environments.
	Personnel/ Equipment Proficiency	Diving	Divers will retrieve torpedoes
		Personnel/ Equipment Air-Drop	Fixed-wing and rotary-wing aircraft deliver paratroopers and equipment to the ice camp. Equipment is dropped by parachute to support camp operations (e.g., food, fuel, building materials) as well as to test search and rescue equipment delivery capability.
		Aircraft Landing Evaluation	Military aircraft are flown to the ice camp to evaluate the use of landing skis on an ice flow runway in the Arctic environment.
	Unmanned Aerial System Testing	Fixed-Wing	Fixed-wing unmanned aerial systems are launched by hand or pneumatic catapult. Fixed-wing systems may have up to a 3 m wingspan and fly at speeds up to 80 knots.
		Rotary-Wing	Rotary-wing unmanned aerial systems ("quadcopters") used individually or simultaneously. Rotary-wing systems are approximately 51 cm square and fly at speeds up to 30 knots.
	Unmanned Underwater Vehicle Testing	Vehicle Testing	Autonomous and tethered unmanned underwater vehicles deployed to test navigation, control, and communications in the polar environment, as well as to gather data on existing oceanographic conditions.

2.3. Standard Operating Procedures and Mitigation Measures

Standard operating procedures and mitigation measures will be implemented during the proposed action. Standard operating procedures serve primarily to provide safety and mission success and are implemented regardless of their secondary benefits (e.g., to a resource). 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. Standard Operating Procedures

2.3.1.1. Camp operations

1. The Navy will comply with NPDES permit requirements for all authorized wastewater discharges from the camp.
2. Wastewater production will be minimized.
    a. No shower facilities will be available at the camp.
    b. Wastewater generated during limited food preparation and dishwashing will be discharged to the Beaufort Sea via a single drain in the camp's dining facility. The drain will utilize a removable metal screen to capture solid debris (i.e., food particles) in the wastewater prior to discharge. The metal screen will have a mesh size of no greater than 0.16 centimeters (cm). Solids captured in the screen will be disposed of via the camp's solid waste containers and brought back to Prudhoe Bay, Alaska, for disposal.
    c. Dishwashing and a hygiene station will use biodegradable, chlorine-, and phosphate-free detergent that meets the Environmental Protection Agency's Safer Choice standards (U.S. Environmental Protection Agency 2015).
3. Sanitary/human waste generated at the camp will be collected in zero-discharge sanitary facilities (e.g., barrels lined with a plastic bag), will be collected and containerized, then flown back to Prudhoe Bay, Alaska, for disposal at appropriate facilities.
4. All material (e.g., construction material, unused food, excess fuel) and wastes (e.g., solid waste, hazardous waste, human waste) will be removed from the ice floe upon completion of ICEX22.
5. Personnel will be trained in the proper handling of fuels, containment procedures, and clean up procedures. Necessary equipment (spill kits, secondary containment) will be provided and accessible.
6. In-camp activities and personnel movement within the camp will only occur during daylight hours to the maximum extent possible.

2.3.1.2. Air Transportation

7. Aircraft will use the shortest route from mainland to the camp that safety and weather conditions will allow.
8. As aircraft approach the camp, aircraft crew will ensure that the landing zone is clear of any animals and will record and report the presence and behavior of any seals observed on the ice.
9. Pilots will make every attempt to avoid large flocks of birds (which are unlikely) in order to reduce the safety risk involved with a potential bird strike.
10. The location for any air-dropped equipment and material will be visually surveyed prior to release of the equipment/material to ensure the landing zone is clear. Equipment and materials will not be released if any animal is observed within the landing zone.

11. Spill response kits/material will be on-site prior to the air-drop of any hazardous material (e.g. fuel).
12. Air drop bundles will be packed within a plywood structure with honeycomb insulation to protect the material from damage.

2.3.1.3. On-ice Transportation

13. Passengers on all ice vehicles will observe for marine and terrestrial animals; any marine or terrestrial animal observed on the ice would be avoided by 100 m (330 ft).
14. On-ice vehicles will not be used to follow any animal (with the exception of actively deterring polar bears if the situation requires).
15. Personnel operating on-ice vehicles will avoid areas of snow drifts >0.5 m in depth (often near pressure ridges), which are preferred areas for ringed seal subnivean lairs.

2.3.1.4. In water Activities

16. For activities involving active acoustic transmission from submarines, passive acoustic sensors on the submarines will listen for vocalizing marine mammals. If a marine mammal is detected, the submarine will cease active transmissions, and not restart until after 15 minutes have passed with no marine mammal detections.
17. The general location and duration of vocalization of marine mammals will be recorded.

2.3.2. Mitigation Measures

The Navy has identified the following mitigation measures in the Biological Assessment to minimize potential impacts from project activities to aid in the recovery or protection of ESA-listed species under NMFS jurisdiction.

2.3.2.1. At camp

1. A demobilization plan is in place in case emergency evacuation from the ice floe is required. After human safety, the plan prioritizes the removal of hazardous wastes from the camp site.
2. All personnel will be required to complete environmental compliance training including environmental health and safety procedures.

2.3.2.2. Air Transportation

3. Fixed wing aircraft will operate at highest altitudes practicable taking into account safety of personnel, meteorological conditions and need to support safe operations of a drifting ice camp. Aircraft will not reduce altitude if a seal is observed on the ice. In general, cruising elevation will be 305 m (1000 ft) or higher.
4. Unmanned Aircraft Systems (UASs) will maintain a minimum altitude of at least 50 feet (15 m) above the ice. They will not be used to track or follow marine mammals.

5. Helicopter flights will use prescribed transit corridors when traveling to/from Prudhoe Bay and the ice camp. Helicopters will not hover or circle above or within 457 m (1,500 ft) of groups of marine mammals.
6. Aircraft will maintain a minimum separation distance of 1.6 km (1 mi) from groups of 5 or more seals.
7. Aircraft will not land on ice within 800 m (0.5 mi) of hauled-out pinnipeds;

2.3.2.3. On-ice Transportation

8. A dedicated observer (not the vehicle operator) will be on each snow machine, or there will be at least one observer for each expeditionary team. Observers for ice trail activities need not be trained protected species observers, but they must be capable of observing and recording marine mammal presence and behaviors, and accurately and completely record data. When traveling, observers will have no other primary duty than to watch for and report observations related to marine mammals and human/seal interactions.
9. Observer will have sufficient equipment (binoculars/monocular, GPS, ability to record information) to aid in observing marine mammals, determining the location of observed marine mammals, and recording observations.
10. Observer will record the date, time, species, number, and geographic coordinate of all seals observed within 150 m (500 ft) of the main camp.
11. Observer will provide an account of interactions, or lack of apparent interaction, between humans (including human operated equipment) and seals or seal lairs that are within 150 m (500 ft) of camps or snow machine trails.
12. Observers or other designated personnel will submit to NMFS a monitoring report in digital format that can be queried. Reporting will occur within 90 days of the cessation of ICEX22 and will provide details about marine mammal observations and interactions that occurred during the exercise.
13. Observers will provide a record of all monitoring efforts, including date, time, duration of observation efforts, duration of time during which seals or seal lairs were known to be present within 150 m (500 ft) of human activities, and the behaviors exhibited by the seals during those observation periods.
14. Observers will record the minimum distance between human activities and seals or seal lairs.
15. If seal lairs are located within 150 m (500 ft) of camps or ice trails, observers will provide an account of the status of lairs through time.
16. If a seal lair or hauled-out seal is disrupted, the disruption will be documented, and details reported to NMFS in the monitoring report.
17. Monitoring reports will be provided to NMFS Permits and Conservation Division, Leah Davis (leah.davis@noaa.gov), pr.itp.monitoringreports@noaa.gov, and the Alaska Region, Marilyn Myers (marilyn.myers@noaa.gov), and AKR.section7@noaa.gov.

2.4. Data Collection and Reporting Requirements

The results of the Navy marine mammal monitoring program, including estimates of "take by harassment" and "take by mortality," will be presented in a technical report, with observer data submitted to NMFS in a digital spreadsheet format that can be queried. The technical report(s) will include:

1. Summaries of monitoring effort: total hours, total distances, and distribution of marine mammals through the study period accounting for weather and other factors affecting visibility and detectability of marine mammals;
2. Species composition, occurrence, and distribution of marine mammal sightings including date, water depth, numbers, age/size/gender categories, group sizes, and ice cover;
3. Observed behaviors and types of movements versus exercise activity;
4. If no seals are seen or detected, that information will also be reported.
5. Report injured or dead marine mammals unrelated to project activities to the Stranding Hotline (Table 2).
6. In the unanticipated event that the specified activity causes the take of a marine mammal in a manner prohibited by the IHA, such as an injury (Level A harassment), serious injury, or mortality, Navy shall report the incident to the Office of Protected Resources, NMFS and the Permits Division. Contact information is in Table 2. The following information will be included:
    a. Time, date, and location of the discovery;
    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(s) was discovered (e.g., snow machine transit, during on-ice experiments, or recon flight).

Table 2. Summary of Agency Contact Information

Reason for Contact	Contact Information
Consultation Questions & Unauthorized Take	Greg Balogh: greg.balogh@noaa.gov Marilyn Myers: Marilyn.myers@noaa.gov Leah Davis: Leah.davis@noaa.gov
Reports & Data Submittal	AKR.section7@noaa.gov (please include NMFS consultation number AKRO 2021-02659) and pr.itp.monitoringreports@noaa.gov

Reason for Contact	**Contact Information**
Stranded, Injured, or Dead Marine Mammal *(not related to project activities)*	Stranding Hotline (24/7 coverage) 877-925-7773
Oil Spill & Hazardous Materials Response	U.S. Coast Guard National Response Center: 1-800-424-8802 or U.S. Coast Guard 17th District Command Center: 907-463-2000 and NMFS AKR Protected Resources Oil Spill Response Coordinator: 907-586-7630 and AKRNMFSSpillResponse@noaa.gov and Sadie.wright@noaa.gov

2.5. 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 the travel corridor between Prudhoe Bay and the ice camp, the area surveyed by reconnaissance flights, the ice camp itself, which will have about a 2 km^2 diameter footprint, and a much larger area that will be used for submarine training and testing. The vast majority of training and research objectives will occur at or near the ice camp, although portions of the submarine training and testing may occur throughout the deep Arctic Ocean basin.

The ice camp will be established in an area approximately 100 to 200 nautical miles (nm) north of Prudhoe Bay, Alaska. The precise location for the ice camp cannot be predicted due to the uncertainty of spring ice conditions. The ice camp requires both multi-year and first-year ice. Prior to set-up, reconnaissance flights are conducted over an area of approximately 70,374 square kilometers (km^2) to locate suitable ice conditions for the location of the ice camp; the whole study area is 2,874,520 square kilometers, which also accounts for submarine maneuvers (Figure 1, purple area).

3. Approach to the Assessment

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

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

Under NMFS's regulations, the destruction or adverse modification of critical habitat means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species (50 CFR § 402.02). Critical habitat has been proposed for ringed seal (86 FR 1452) but it is not expected to be finalized before this project has concluded. For these reasons the effects of the proposed project on critical habitat will not be discussed.

We use the following approach to determine whether the proposed action described in Section 2 of this opinion is likely to jeopardize the ringed and bearded seals:

1. Identify those aspects (or stressors) of the proposed action that are likely to have effects on the ringed and bearded seals. As part of this step, we identify the action area – the spatial and temporal extent of these effects.
2. Identify the range-wide status of the species. This section describes the current status of the listed species. Species status is discussed in Section 4 of this opinion.
3. 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.
4. Analyze the effects of the proposed action. Identify the effects that will overlap with ringed and bearded seals in space and time and the nature of that co-occurrence (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. 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.
    a. Once we identify the nature of the exposure, we examine the scientific and commercial data available to determine whether and how the listed species is likely to respond given their exposure (these represent our *response analyses*). Response analysis is considered in Section 6.3 of this opinion.
5. 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.

6. Integrate and synthesize the above factors to assess the risk that the proposed action poses to the ringed seal. 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:
    a. appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or
    b. appreciably diminish the value of critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species (Section 4). Integration and synthesis with risk analyses occurs in Section 8 of this opinion.
7. Reach jeopardy and adverse modification conclusions. Conclusions regarding jeopardy and the destruction or adverse modification of critical habitat, if applicable, are presented in Section 9. These conclusions flow from the logic and rationale presented in the Integration and Synthesis Section 8.
    a. 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

This opinion considers the effects of the proposed action on the species specified in Table 3. Critical habitat has not been designated for Arctic ringed seals.

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

Species	Status	Listing	Critical Habitat
Ringed Seal, Arctic Subspecies (*Phoca hispida hispida*)	Threatened	NMFS 2012, 77 FR 76706	Proposed 86 FR 1452
Bearded Seal, Beringia DPS *(Erignathus barbatus nauticus)*	Threatened	NMFS 2012, 77 FR 76740	Proposed 86 FR 1433

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

4.1.1. Bearded Seal

As with ringed seals, critical habitat has been proposed for bearded seals (86 FR 1433) but it is not expected to be finalized before this project has concluded. Therefore, the effects of project activities on critical habitat for bearded seals is not analyzed.

Within the U.S. range of the Beringia DPS, the extent of favorable ice conditions in the Beaufort Sea for bearded seals is limited to where there is a relatively narrow ice-shelf with suitable water depths. The most probable area in which bearded seal might be found within the action area during winter months is along the continental shelf of the Beaufort Sea. Bearded seals feed extensively on benthic invertebrates (e.g. clams, gastropods, crabs, shrimp, bottom-dwelling fish) (Quakenbush et al. 2011, Cameron et al. 2010) and are typically found in water depths of 200 m (656 ft) or less (Burns 1970). The Bureau of Ocean Energy Management (BOEM) conducted an aerial survey from June through October that covered the shallow Beaufort and Chukchi Sea shelf waters, and observed bearded seals from Point Barrow to the border of Canada (Clarke et al. 2015). The farthest from shore that bearded seals were observed was the waters of the continental slope.

Although acoustic data indicate that some bearded seals may remain in the Beaufort Sea year round (MacIntyre et al. 2013, Jones et al. 2014, MacIntyre et al. 2015), satellite tagging data (Boveng and Cameron 2013, ADF&G 2017) show that large numbers of bearded seals move south in fall/winter with the advancing ice edge to spend the winter in the Bering Sea, confirming prior visual observations (Burns and Frost 1979; Frost et al. 2008; Cameron and Boveng 2009). The southward movement of bearded seals in the fall means that very few individuals are expected to occur along the Beaufort Sea continental shelf in February through early April, the timeframe of the proposed activities. The northward spring migration through Bering Strait, occurs from mid-April through June (Burns and Frost 1979), at which time ICEX2022 activities will be over.

It is anticipated that the ice camp will be established 100-200 nm (185-370 km) north of Prudhoe Bay in water depths of 800 m or more. The continental shelf near Prudhoe Bay is approximately 55 nm (100 km) wide. Therefore, even if the ice camp were established at the closest estimated distance (100 nm from Prudhoe Bay), it would still be approximately 45 nm (83 km) distant from habitat potentially occupied by bearded seals. The sound created by the sonar is not expected to have any impact on marine mammals beyond 10 km (5.4 nm) (Navy 2019). Although bearded seals are found 20 to 100 nm (37 to 185 km) offshore during spring (Simpkins et al. 2003, Bengtson et al. 2005), winter is a time we expect bearded seals to select habitats where food is abundant and easily accessible to minimize the energy required to forage and maximize energy reserves in preparation for whelping, lactation, mating, and molting. Bearded seals are not known to dive to 800 m to forage and it is highly unlikely that they would be in the vicinity of the camp or where the research activities will be conducted. Because there will be at least 80 km between the ice camp and where bearded seals are likely to occur, and because sonar effects are not expected to extend beyond 10 km, we conclude that the chance of a bearded seal being exposed to sonar sound created by ICEX2022 activities is extremely unlikely. We do not anticipate adverse effects to bearded seals from sonar use.

Noise will also be created by snow machines at the camp and by aircraft flying overhead that will transport supplies and personnel from Prudhoe Bay to the ice camp. Similar to sonar, it is extremely unlikely that bearded seals will be exposed to sound from snow machines because the distance between the ice camp and where any bearded seals may occur at that time of year (along the continental shelf) is a minimum of 45 nm (83 km) away. Any noise created by snow machines or aircraft will be greatly attenuated at that distance.

Because bearded seals will not be near the ice camp location, they will only be exposed to aircraft noise from the overflights after takeoff or before landing from the Deadhorse Airport. Aircraft noise will not be novel to any bearded seals that remain in the area because approximately 90 flights per day occur from the Deadhorse Airport (Navy 2019). ICEX2022 would increase air traffic from the airport by approximately 10 percent (maximum of 9 trips per day during camp build-up and demobilization, and one to three trips during ice camp operations). It is approximately 15 km between Deadhorse Airport and the coastline. The loudest aircraft noise (from takeoff and landing) will be attenuated by the distance from shore. All aircraft should easily be able to reach cruising altitude by the time they reach the coast, diminishing the magnitude of sound reaching the ice below.

Potential effects on bearded seals from aircraft activity could involve both acoustic and non-acoustic (visual) effects. It is uncertain if an animal reacts to the sound of the aircraft or to its physical presence flying overhead, or both. It has been noted that pinniped hearing sensitivity is reduced at frequencies below 2 kHz, and generally pinnipeds are less sensitive than humans to airborne sounds less than 10 kHz (Richardson et al. 1995). The noise created by the aircraft in flight proposed for use in ICEX2022 will be 1.7 kHz or less (Navy 2019). Reactions of hauled out pinnipeds to aircraft flying overhead have been noted, such as looking up at the aircraft, moving on the ice or land, entering a breathing hole or crack in the ice, or entering the water (Blackwell et al. 2004; Born et al. 2004). Reactions depend on several factors including the animal’s behavioral state, activity, group size, habitat, and the flight pattern of the aircraft (Richardson et al. 1995).

Overall, there has been no indication that aircraft flying above pinnipeds in water cause long term displacement of these animals (Richardson et al. 1995). In the unlikely event that a bearded seal is hauled out and disturbed by the aircraft, it is highly unlikely this brief disturbance would interfere with any essential life function, such as breeding or feeding. We do not expect temporal overlap between breeding behaviors and aircraft activity associated with this project. Therefore, aircraft sound passing through the air-ice/water interface is extremely unlikely to impact breeding behaviors, including vocalizations. Taking all of these factors into account, we conclude that a few individuals may be exposed to overflight noise but the exposure would be brief and transitory, it would be noise they are accustomed to, and it is not likely to disrupt normal behavioral patterns, so harassment is not expected (Wieting 2016).

Other activities associated with ICEX22 including construction of a camp, deployment of hydrophones, discharge of gray water and saline water, use of unmanned underwater vehicles, and use of Unmanned Aircraft Systems will all occur at least 45 nm (83 km) from bearded seal winter habitat. Therefore, we conclude that it is highly unlikely that any of these activities will adversely affect bearded seals because they will not be exposed to the activities.

4.2. Climate Change

A common threat to listed Arctic species is climate change. In this section we provide an overview of the major changes occurring in the Arctic. A vast amount of literature is available on climate change and for more detailed information we refer the reader to the following websites which provide the latest data and links to the current state of knowledge on the topic in general, and in the Arctic specifically:

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

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

http://nsidc.org/arcticseaicenews/

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

Ringed and bearded seals depend on the ocean and Arctic ice for every aspect of their life history. Factors which affect the ocean and ice, like temperature and pH, can have direct and indirect impacts on ringed seals and the resources they depend upon. In this section we provide background on the physical effects climate change has caused on a broad scale; then we focus on changes that have occurred in Alaska. Finally, we provide an overview of how these physical changes translate to biological effects.

4.2.1. Physical Effects

4.2.1.1. Air Temperature

There is consensus throughout the scientific community that atmospheric temperatures are increasing, and will continue to increase, for at least the next several decades (IPCC 2021). Global surface temperature was 1.09 (0.95 to 1.20) °C higher in 2011–2020 than 1850–1900, with larger increases over land than over the ocean IPCC (2021).

Continued emission of greenhouse gases is expected to cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems (IPCC 2021). The decadal global land and ocean surface average temperature anomaly for 2011–2020 indicates that it was the warmest decade on record for the globe, with a surface global temperature of +0.82°C (+1.48°F) above the 20th century average[1]. This surpassed the previous decadal record (2001–2010) value of +0.62°C (+1.12°F)[2]. The 2020 Northern Hemisphere land and ocean surface temperature was the highest in the 141-year record at +1.28°C (+2.30°F) above average. This was 0.06°C (0.11°F) higher than the previous record set in 2016[2].

The impacts of climate change are especially pronounced at high latitudes. Since 2000, the Arctic (latitudes between 60ºN and 90ºN) has been warming at more than two times the rate of lower latitudes because of "Arctic amplification," a characteristic of the global climate system influenced by changes in sea ice extent, atmospheric and oceanic heat transports, cloud cover, albedo, black carbon, and many other factors[3] (Serreze and Barry 2011, Overland et al. 2017). Across Alaska, average air temperatures have been increasing, and the average annual temperature is now 1.65-2.2°C (3-4°F) warmer than during the early and mid-century (Thoman and Walsh 2019). Winter temperatures have increased by 3.3°C (6˚F) (Chapin et al. 2014) and the snow season is shortening (Thoman and Walsh 2019). The statewide average annual temperature in 2020 was 27.5°F, 1.5°F above the long-term average even though it was the coldest year since 2012[4]. Some of the most pronounced effects of climate change in Alaska include disappearing sea ice, shrinking glaciers, thawing permafrost, and changing ocean

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

temperatures and chemistry (Chapin et al. 2014).

4.2.1.2. Ocean Heat

Higher air temperatures have led to higher ocean temperatures. More than 90% of the excess heat created by global climate change is stored in the world's oceans, causing increases in ocean temperature (IPCC 2019, Cheng et al. 2020). The upper ocean heat content, which measures the amount of heat stored in the upper 2000 m (6,561 ft) of the ocean, was the highest on record in 2019 by a wide margin, and is the warmest in recorded human history (Cheng et al. 2020). The seas surrounding Alaska have been unusually warm in recent years, with unprecedented warmth in some cases (Thoman and Walsh 2019). This effect can be seen throughout the Alaska region, including the Bering, Chukchi, and Beaufort seas (Figure 6) (Thoman and Walsh 2019).

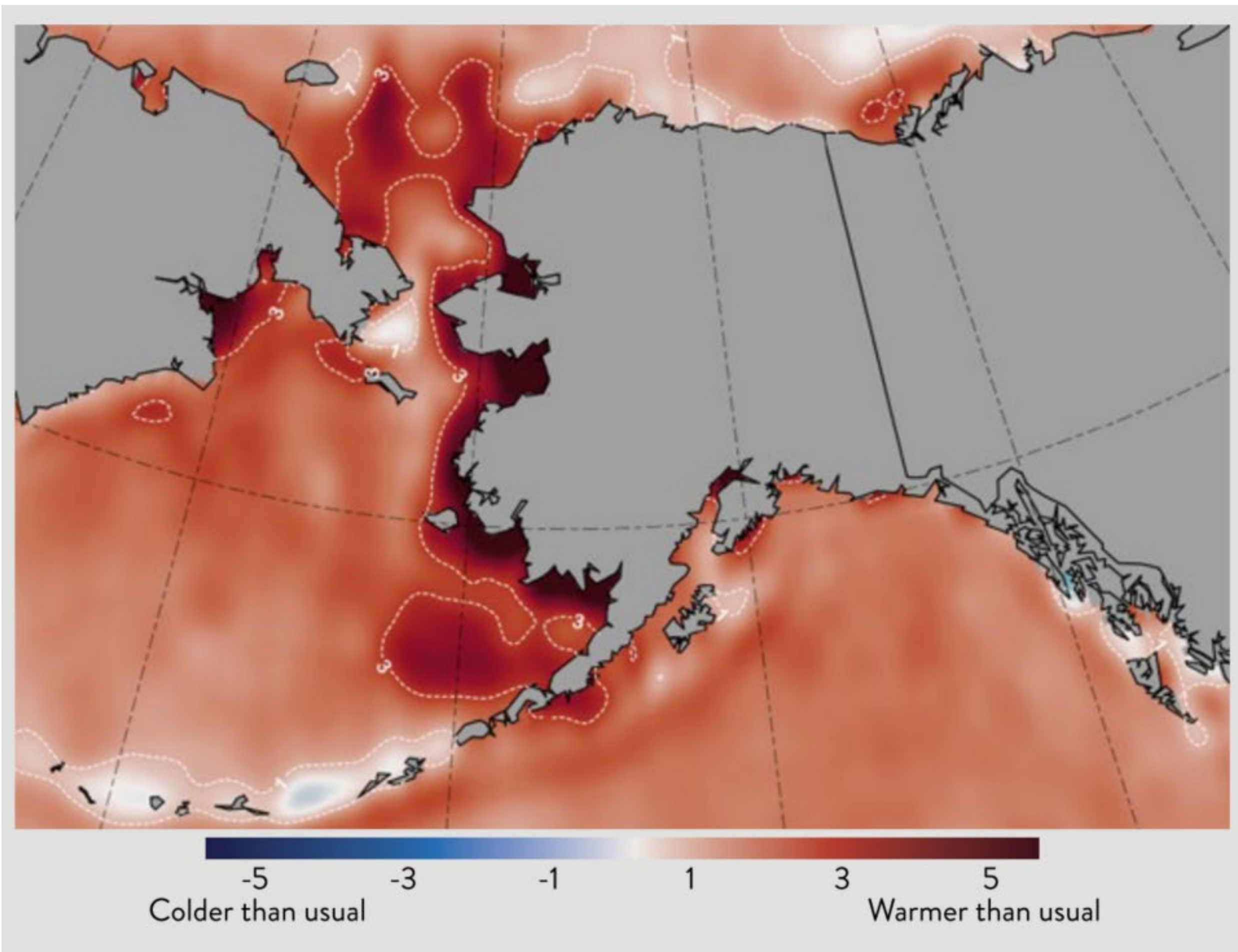


Figure 6. Arctic summer sea surface temperatures, 2019 (Thoman and Walsh 2019).

Warmer ocean water affects sea ice formation and melt. In the first decade of the 21st century, Arctic sea ice thickness and annual minimum sea ice extent (i.e., September sea ice extent) declined at a considerably accelerated rate and continues to decline (Stroeve et al. 2007, Stroeve and Notz 2018) (Figure 7). Approximately three-quarters of summer Arctic sea ice volume has been lost since the 1980s (IPCC 2013). In addition, old ice (> 4 years old), which is thicker and more resilient to melting than young ice, constituted 33% of the ice pack in 1985, but by March 2019, it represented only 1.2% of the ice pack in the Arctic Ocean (Perovich et al. 2019). Multiyear ice for 2021 in the Artic as a whole is at a record low[5]. Overland (2020) suggests that the loss of the thicker older ice makes the Arctic ecosystem less resilient. Both the maximum sea ice extent (March) and the minimum (September) have consistently been decreasing, although the summer minimums are more pronounced (Perovich et al. 2019) (Figure 7). The minimum Arctic sea ice extent in 2019 was effectively tied with 2007 and 2016 for second lowest, only behind 2012, which is the record minimum[6].

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

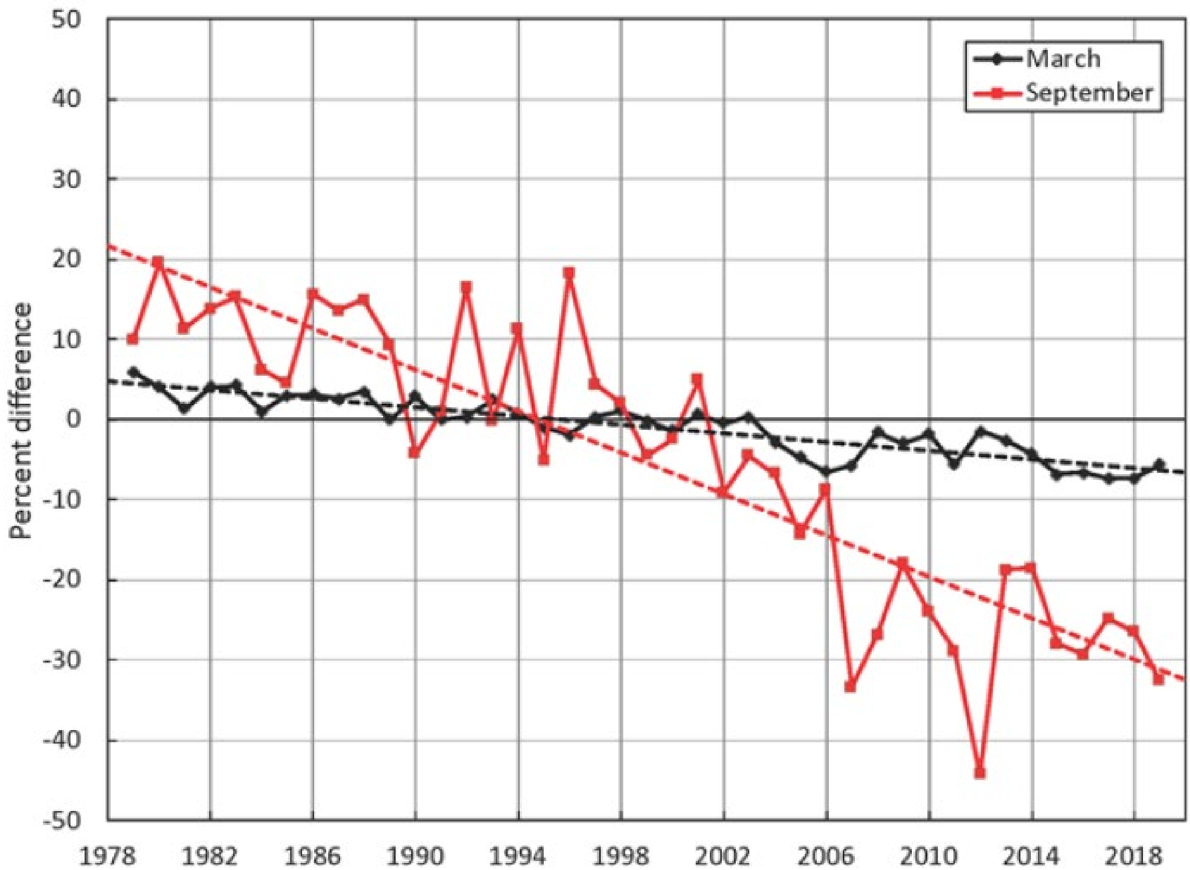


Figure 7. Arctic ice extent declines in September (red) and in March (black). The value for each year is the difference in percent in ice extent relative to the mean values for 1981-2010. Both trends are significant at the 99% confidence level. The slopes of the lines indicate losses of -2.7

[5] http://nsidc.org/arcticseaicenews/ viewed August 23, 2021

[6] National Snow and Ice Data Center. Monthly Archives. http://nsidc.org/arcticseaicenews/2019/09/

for the maximum ice extent and -12.9 percent for the minimum ice extent, per decade.

Related to the loss of sea ice is the northward shift and near loss of the cold-water pool in the eastern Bering Sea. Winter sea ice creates a pool of cold (<2ºC) bottom water that is protected from summer mixing by a thermocline (Mueter and Litzow 2008). With the reduction in winter sea ice, the cold-water pool has shrunk (Figure 8). Many temperate species, especially groundfish, are intolerant of the low temperatures so the extent of sea ice determines the boundary between arctic and subarctic seafloor communities and demersal vs pelagic fish communities (Grebmeier et al. 2006). In the Pacific Arctic, large scale, northward movements of commercial stocks are underway as previously cold-dominated ecosystems warm and fish move northward to higher latitude, relatively cooler environments (Grebmeier et al. 2006, Eisner et al. 2020). Not only fish, but plankton, crabs and ultimately, sessile invertebrates like clams are affected by these changes in water temperature (Grebmeier et al. 2006, Fedewa et al. 2020).

Another consequence of warmer ocean temperatures in the Arctic is the spread of algae which produce potent biotoxins. *Alexandrium catenella* is a cyst forming-dinoflagellate that causes paralytic shellfish poisoning. Hydrographic conditions and warmer temperatures have created two large cyst accumulation zones in the Chukchi Sea with cyst concentrations among the highest reported globally (Anderson et al. 2021). The region is poised to support annually recurrent blooms that are massive in scale (Anderson et al. 2021). These blooms could negatively impact marine mammal and human health.

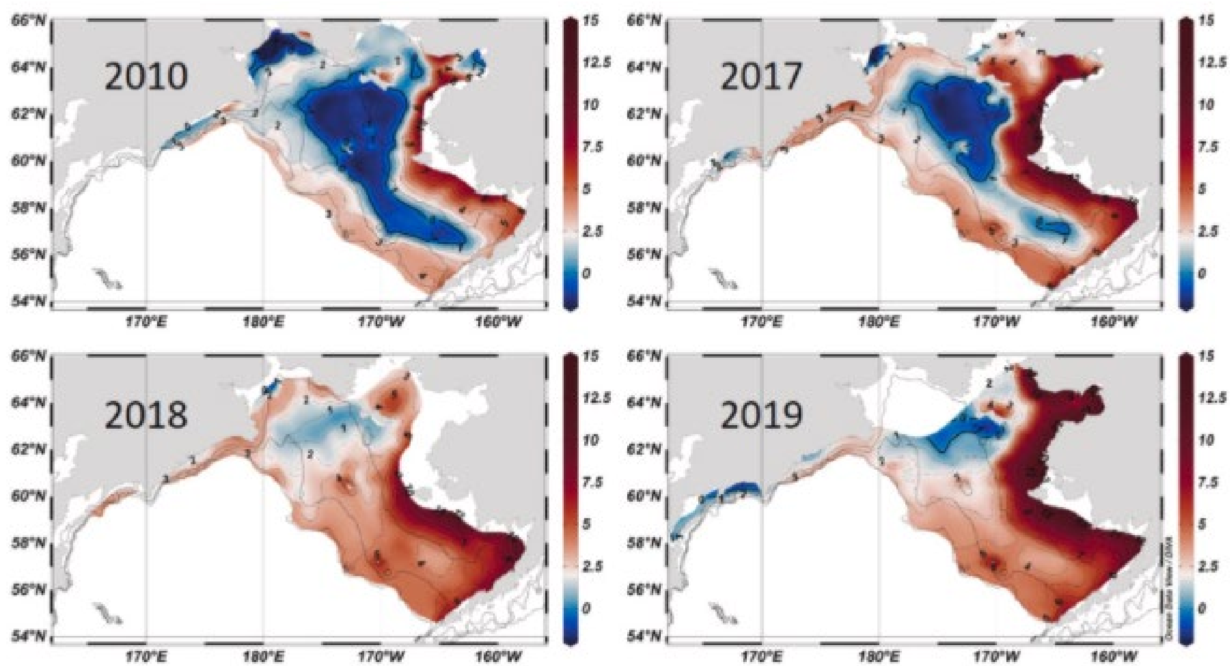


Figure 8. Bottom temperatures from summer oceanographic surveys. Graphic display of the shrinkage of the cold pool over time. From (Eisner et al. 2020).

4.2.1.3. Ocean Acidification

For 650,000 years or more, the average global atmospheric carbon dioxide (CO_2) concentration varied between 180 and 300 parts per million (ppm), but since the beginning of the industrial revolution in the late 1700s, atmospheric CO_2 concentrations have been increasing rapidly, primarily due to anthropogenic inputs (Fabry et al. 2008, Lüthi et al. 2008). The world's oceans have absorbed approximately one-third of the anthropogenic CO_2 released, which has buffered the increase in atmospheric CO_2 concentrations (Feely et al. 2004, Feely et al. 2009). Despite the oceans' role as large carbon sinks, the CO_2 level continues to rise and is currently over 410 ppm[7].

As the oceans absorb CO_2, the pH of seawater is reduced. This process is referred to as ocean acidification. Ocean acidification reduces the saturation states of certain biologically important calcium carbonate minerals like aragonite and calcite that many organisms use to form and maintain shells (Bates et al. 2009, Reisdorph and Mathis 2014). When seawater is supersaturated with these minerals, calcification (growth) of shells is favored. Likewise, when the sea water becomes undersaturated, dissolution is favored (Feely et al. 2009).

High latitude (colder) oceans have naturally lower saturation states of calcium carbonate minerals than more temperate or tropical waters, making Alaska's oceans more susceptible to the effects of ocean acidification (Fabry et al. 2009, Jiang et al. 2015). Model projections indicated that aragonite undersaturation would start to occur by about 2020 in the Arctic Ocean and by 2050, all of the Arctic will be undersaturated with respect to aragonite (Feely et al. 2009, Qi et al. 2017). Large inputs of low-alkalinity freshwater from glacial runoff and melting sea ice contribute to the problem by reducing the buffering capacity of seawater to changes in pH (Reisdorph and Mathis 2014). As a result, seasonal undersaturation of aragonite was already detected in the Bering Sea at sampling stations near the outflows of the Yukon and Kuskokwim Rivers, and the Chukchi Sea (Fabry et al. 2009). Models and observations indicate that rapid sea ice loss will increase the uptake of CO_2 and exacerbate the problem of aragonite undersaturation in the Arctic (Yamamoto et al. 2012, DeGrandpre et al. 2020).

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

4.2.2. Biological Effects

Climate change is projected to have substantial direct and indirect effects on individuals, populations, species, and the structure and function of marine, coastal, and terrestrial ecosystems in the foreseeable future (Hinzman et al. 2005, Burek et al. 2008, Doney et al. 2012, Huntington et al. 2020). The physical effects on the environment described above have impacted, are

[7] NOAA Global Monitoring Laboratory website. Trends in Atmospheric Carbon Dioxide. Available at https://www.esrl.noaa.gov/gmd/ccgg/trends/, accessed November 10, 2020.

impacting, and will continue to impact marine species in a variety of ways (IPCC 2014), such as:

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

Some of the biological consequences of the changing Arctic conditions are shown in Table 4.

Table 4. A summary of possible direct and indirect health effects for Arctic marine mammals related to climate change, adapted from (Burek et al. 2008).

Effect	Result
Direct	
Increase in ocean temperature	Changes in distribution and range (fish, whales) Increase in harmful algal blooms (all affected) Loss of suitable habitat Change in prey base
Loss of sea ice platform (seals)	Reduction of suitable habitat for feeding, resting, molting, breeding Movement, distribution, life history may be affected
Changes in weather	Reduction in snow on sea ice, loss of suitable lair habitat for ringed seals
Ocean acidification	Changes in prey base (all affected)
Indirect	
Changes in infectious disease transmission (changes in host–pathogen associations due to altered pathogen transmission or host resistance)	Increased host density due to reduced habitat, increasing density-dependent diseases. Epidemic disease due to host or vector range expansion. Increased survival of pathogens in the environment. Interactions between diseases, loss of body condition, and increased immunosuppressive contaminants, resulting in increased susceptibility to endemic or epidemic disease.
Alterations in the predator–prey relationship	Affect body condition and, potentially, immune function.
Changes in toxicant pathways (harmful algal blooms, variation in long-range transport, biotransport, runoff, increased use of the Arctic)	Mortality events from biotoxins Toxic effects of contaminants on immune function, reproduction, skin, endocrine systems, etc.

Effect	Result
Other negative anthropogenic impacts related to longer open water period	Increased likelihood of ship strikes, fisheries interactions, acoustic injury Chemical and pathogen pollution due to shipping or aquaculture practices. Introduction of nonnative species

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

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

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

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

4.3.1. Ringed seal

4.3.1.1. Status and Population Structure

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 ice and snow cover stemming from climate change within the foreseeable future (77 FR 76706). A recovery plan has not been written for the Arctic ringed seal.

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

Though a reliable population estimate for the entire Alaska stock is not available, research programs have recently developed new survey methods and partial, but useful, abundance estimates. In spring of 2012 and 2013, U.S. and Russian researchers conducted image-based aerial abundance and distribution surveys of the entire Bering Sea and Sea of Okhotsk (Moreland et al. 2013). The data from these surveys are still being analyzed, but for the U.S. portion of the Bering Sea, Boveng et al. (2017) reported model-averaged abundance estimates of 186,000 and 119,000 ringed seals in 2012 and 2013, respectively. It was noted that these estimates should be viewed with caution because a single point estimate of availability (haul-out correction factor) was used and the estimates did not include ringed seals in the shorefast ice zone, which was surveyed using a different method. The authors suggested that the difference in seal density between years may reflect differences in the numbers of ringed seals using Russian versus U.S. waters between years, and they noted that if this was the case, the eventual development of comprehensive estimates of abundance for ringed seals in the Bering Sea that incorporate data in Russian waters may show less difference between years. Due to the lack of precise population estimates, the population trends for the Arctic subspecies and Alaska stock are unknown. For the purposes of the IHA, the Permits Division used a conservative population estimate of 171,418 (95 percent CI: 141,588-201,090) based on a subsample of data collected from the U.S. portion the Bering Sea in 2012 (Conn et al. 2014).

4.3.1.2. 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. 2010b, Harwood et al. 2015). Harwood and Stirling (1992) reported that in late summer and early fall, aggregations of ringed seals in open-water in some parts of their study area in the southeastern Canadian Beaufort Sea where primary productivity was thought to be high. Harwood et al. (2015) also found that in the fall, several satellite-tagged ringed seals showed localized movements offshore east of Point Barrow in an area where bowhead whales are known to concentrate in the fall to feed on zooplankton. With the onset of freeze-up in the fall, ringed seal movements become increasingly restricted. Seals that have summered in the Beaufort Sea are thought to move west and south with the advancing ice pack, with many seals dispersing throughout the Chukchi and Bering seas while some remain in the Beaufort Sea (Frost and Lowry 1984, Crawford et al. 2012, Harwood et al. 2012). Some adult ringed seals return to the same small home ranges they occupied during the previous winter (Kelly et al. 2010).

4.3.1.3. 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 1988b), and therefore are in the study area. Passive acoustic monitoring (PAM) of ringed seals from a high frequency recording package deployed at a depth of 787 ft. (240 m) in the Chukchi Sea (65 nm) 120 km north-northwest of Barrow, Alaska detected ringed seals in the area between mid-December and late May over the four year study (Jones et al. 2014). At the onset of the fall freeze, ringed seal movements become increasingly restricted and seals move west and south with the advancing ice pack into the Chukchi and Bering Seas, with some remaining in the Beaufort Sea (Frost and Lowry 1984, Crawford et al. 2012, Harwood et al. 2012).

A density estimate of 0.3958 ringed seals per km^2 was used (among other information) to estimate take (see Section 10). This density estimate was derived from habitat-based modeling by (Kaschner 2004) and (Kaschner et al. 2006). The study area in the Beaufort Sea has not been surveyed in a manner that supports quantifiable density estimation of marine mammals. In the absence of empirical survey data, information on known or inferred associations between marine habitat features and the likelihood of the presence of specific species have been used to predict densities using model-based approaches. These habitat suitability models include relative environmental suitability (RES) models. Habitat suitability models can be used to understand the possible extent and relative expected concentration of a marine species distribution. These models are derived from an assessment of the species occurrence in association with evaluated environmental explanatory variables that results in defining the RES suitability of a given environment. A fitted model that quantitatively describes the relationship of occurrence with the environmental variables can be used to estimate unknown occurrence in conjunction with known habitat suitability. Abundance can thus be estimated for each RES value based on the values of the environmental variables, providing a means to estimate density for areas that have not been surveyed.

4.3.1.4. Threats

The primary threat to the Arctic ringed seal is diminishing ice and snow cover as a consequence of climate change. As discussed in section 4.1 the duration of ice cover is projected to be substantially reduced in the future. Snow cover adequate for the formation and occupation of birth lairs is forecasted to be greatly reduced. Without the protection of lairs, ringed seals, especially newborn, are vulnerable to freezing and predation. In addition, other consequences of climate change that lead to impacts on prey, increased harmful algal blooms, or susceptibility to disease could also impact population viability.

4.3.1.5. Feeding, Diving, Hauling out and Social Behavior

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

Mating is thought to take place under the ice in the vicinity of birth lairs while mature females are still lactating (Kelly et al. 2010a). 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 9 summarizes the approximate annual timing of Arctic ringed seal reproduction and molting (Kelly et al. 2010a).

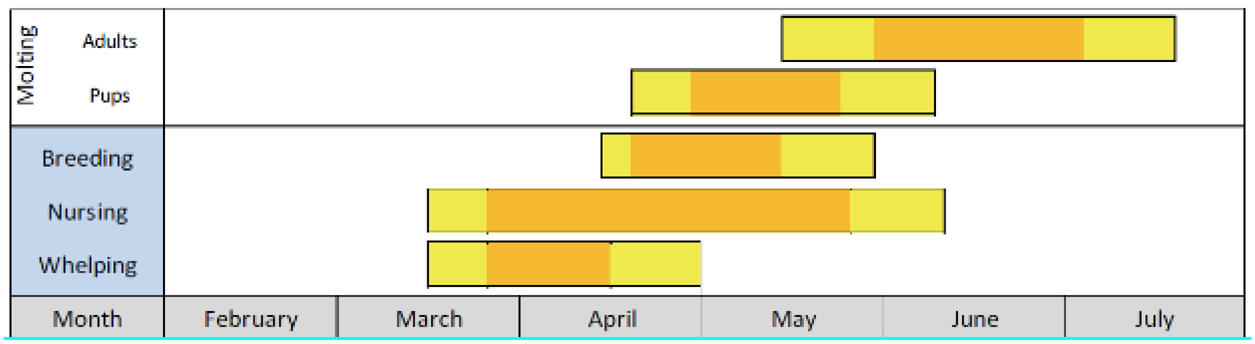


Figure 9. Approximate annual timing of Arctic ringed seal reproduction and molting. Yellow bars indicate the “normal” range over which each event is reported to occur and orange bars indicate the “peak” timing of each event (Kelly et al. 2010a).

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

Ringed seals feed year-round, but forage most intensively during the open-water period and early freeze-up, when they spend 90 percent or more of their time in the water (Kelly et al. 2010a). Many studies of the diet of Arctic ringed seal have been conducted and although there is considerable variation in the diet regionally, several patterns emerge. Preferred prey tends to be schooling fish species that form dense aggregations. Fish of the cod family tend to dominate the diet from late autumn through early spring in many areas (Kovacs 2007). Arctic cod (*Boreogadus saida*) is often reported to be the most important prey species for ringed seals, especially during the ice-covered periods of the year (Lowry et al. 1980, Smith 1987, Holst et al. 2001, Labansen et al. 2007). Quakenbush et al. (2011) reported evidence that in general, the diet of Arctic ringed seals sampled from Alaska waters consisted of cod, amphipods, and shrimp. Fish are generally more commonly eaten than invertebrate prey, but diet is determined to some extent by availability of various types of prey during particular seasons as well as preference, which in part is guided by energy content of various available prey (Reeves 1998, Wathne et al. 2000). Invertebrate prey seem to become more important in the diet of Arctic ringed seals in the open-water season and often dominate the diet of young animals (e.g., Lowry et al. 1980, Holst et al. 2001).

4.3.1.6. Hearing, Vocalizations, and Other Sensory Capabilities

Ringed seals vocalize underwater in association with interspecific behaviors. Stirling (1973) concluded that no vocalizations played a role solely in reproductive behavior. Underwater audiograms for phocids suggest that they have very little hearing sensitivity below 1 kHz, and make calls between 90 Hz and 16 kHz (Richardson et al. 1995). NMFS defines the functional hearing range for phocids as 50 Hz to 86 kHz (NMFS 2018). Ringed seals do not echolocate to communicate or find prey. Unlike many other phocids, ringed seal vocalizations cannot be heard by a human on the ice. Stirling and Thomas (2003) suggest that the exceptionally low signal strength of ringed seal vocalizations may have evolved in part to avoid detection by polar bears.

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

5. Environmental Baseline

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

5.1. Climate Change

All areas of the action area are being affected by climate change. Although the species living in the Arctic successfully adapted to changes in the climate in the past, the current rate of change is accelerated (Simmonds and Eliott. 2009). The life cycles and physiological requirements of many specialized polar species are closely linked to the annual cycles of sea ice and photoperiod and they may not be able to quickly adapt (Doney et al. 2009, Wassmann et al. 2011). Additionally, the loss of sea ice as a barrier increases the potential for further anthropogenic impacts as vessel traffic for transportation and tourism increases, resource extraction activities expand, and pathogens or disease have a path into newly ice-free regions.

As discussed in Section 4.2, the Arctic is warming at two or more times the global average. One consequence of the warming is a reduction in the length of the snow season (Figure 10). The depth and duration of snow cover are projected to continue to decline substantially throughout the range of the Arctic ringed seal, reducing the areas with suitable snow depths for their lairs by an estimated 70 percent by the end of this century (Hezel et al. 2012). It has been observed that the mean thickness of snow accumulating on sea ice has declined from approximately 35 to 22 cm in the western Arctic and 33 to 15 cm in the Beaufort and Chukchi Seas since the mid-1900s (Webster et al. 2014). A decrease in the availability of suitable sea ice conditions (including depth of snow on ice available for lair formation) may not only lead to high mortality of ringed seal pups but may also produce behavioral changes in seal populations (Loeng et al. 2005). The persistence of this species will likely be challenged as decreases in ice and, especially, snow cover lead to increased juvenile mortality from premature weaning, hypothermia, and predation (Kelly et al. 2010b).

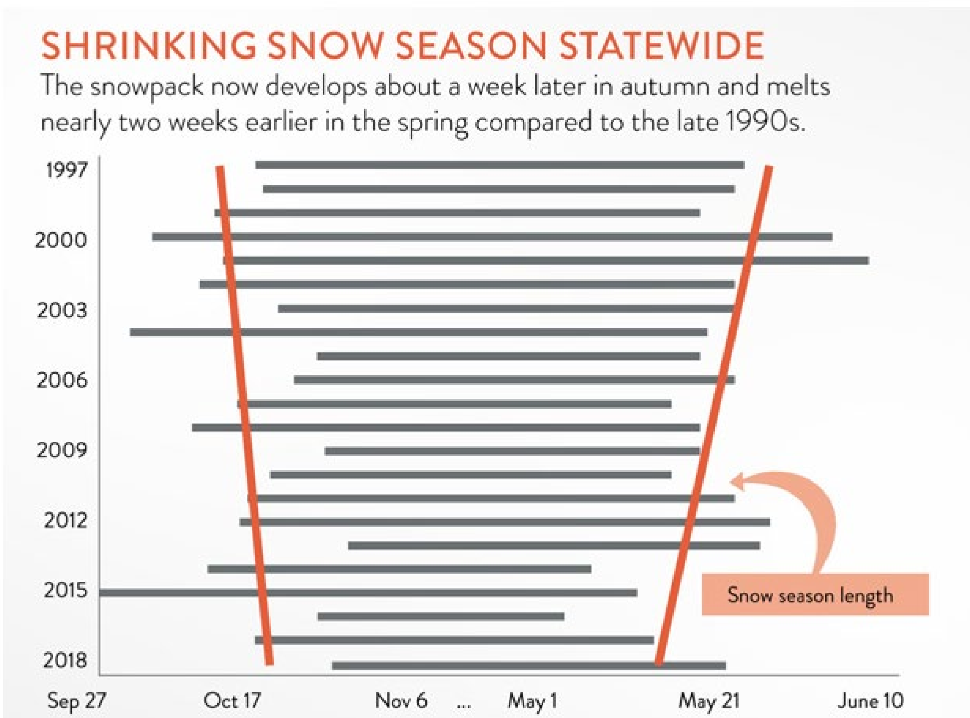


Figure 10. Length of the snow season (gray bars) in Alaska each year from 1997-2018. Orange slanting bars show the trends of the date when the state becomes 50 percent snow covered in fall and when half the winter snow has melted in spring. Image by Rick Thoman, Alaska Center for Climate and Policy.

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

5.1.1. Biotoxins

As temperatures in the Arctic waters warm and sea ice diminishes, marine mammal health may be compromised through nutritional and physiological stress, and toxins from harmful algal blooms. *Alexandrium catenella*, a cyst-forming dinoflagellate creates a potent biotoxin, saxitoxin or paralytic shellfish poison. An exceptionally large cyst bed has been documented in the Chukchi Sea that can support germination and the development of recurrent, locally originating blooms (Anderson et al. 2021). Cyst concentrations are among the highest reported globally for this species and the cyst bed is at least six times larger in area than any other (Anderson et al. 2021). The region is now poised to support annual blooms that are massive in scale (Anderson et al. 2021). 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. Domoic acid, another biotoxin produced by diatoms, 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). Although biotoxins can cause death, they can also cause sublethal effects including reproductive failure and chronic neurological disease (Broadwater et al. 2018).

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 for the presence of biotoxins (Figure 11). Domoic acid and saxitoxin (a form of paralytic shellfish poison) were both found in ringed seals (Lefebvre et al. 2016). It is not known if exposure to multiple toxins result in additive or synergistic effects or perhaps suppress immunity to make animals more vulnerable to secondary stressors (Broadwater et al. 2018). With declining sea ice, warmer water temperatures, and changes in ocean circulation patterns, NOAA anticipates that harmful algal blooms in the Arctic will likely worsen in the future[8].

[8] NOAA Arctic Program. Arctic Report Card: Update for 2018, Available at https://arctic.noaa.gov/Report-Card/Report-Card-2018/ArtMID/7878/ArticleID/789/Harmful-Algal-Blooms-in-the-Arctic, accessed November 10, 2020.

Figure 11. Algal toxins detected in 13 species of marine mammals from southeast Alaska to the Arctic from 2004 to 2013 (Lefebvre et al. 2016).Marine mammal species are listed as follows: (A) humpback whales, (B) bowhead whales, (C) beluga whales, (D) harbor porpoises, (E) northern fur seals, (F) Steller sea lions, (G) harbor seals, (H) ringed seals, (I) bearded seals, (J) spotted seals, (K) ribbon seals, (L) Pacific walruses and (M) northern sea otters.

5.1.2. Disease

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

Likewise, in 2019, a UME was declared for bearded, ringed, and spotted seals in the Bering and Chukchi seas because of elevated mortality documented starting in June 2018 and continuing through the summer of 2019. Since June 1, 2018, NMFS confirmed 368 strandings[9] (Table 5). The cause of the UME has not been determined but many of the seals had low fat thickness. All

[9]NOAA Fisheries. 2018-2020 Ice seal unusual mortality event in Alaska webpage. Available at: https://www.fisheries.noaa.gov/alaska/marine-life-distress/2018-2020-ice-seal-unusual-mortality-event-alaska, accessed November 10, 2020.

age classes were affected. The seals that were sampled did not have the hair loss or skin lesions that were prominent in the prior UME. Subsistence hunters noted that some of the seals had less fat than normal. The lowest sea ice maximums occurred in 2017 and 2018 when the retreat of sea ice was very rapid. It is unknown if these extreme sea ice conditions played a role in the health of the seals.

Table 5. Stranded seals in the Bering and Chukchi seas from 2018-2021.

Year	Bearded	Ringed	Spotted	Unidentified	Total
2018 (June 1-Dec 31)	35	29	20	27	111
2019	50	35	26	53	164
2020	10	9	8	11	38
2021 (as of Nov 17)	11	22	8	14	55
Total*	**106**	**94**	**62**	**105**	**368**
*June 1, 2018 - 27 November 2021. Source: https://www.fisheries.noaa.gov/alaska/marine-life-distress/2018-2020-ice-seal-unusual-mortality-event-alaska					

5.2. Fisheries

While no commercial fishing is currently authorized in the Beaufort Sea, ringed seals may be impacted by commercial fishing interactions as they migrate through the Bering Sea to the Chukchi and Beaufort seas. Commercial fisheries may impact ringed seals through direct interactions (i.e., incidental take or bycatch) and indirectly through competition for prey resources and other impacts on prey populations (e.g. disruption or destruction of prey habitat). From 2013 to 2017 the minimum estimated mean annual mortality and serious injury rate for ringed seals by the U.S. commercial fisheries was 2.4 for the Bering Sea/Aleutian Island flatfish trawl (Muto et al. 2020). Entanglement and entrapment in trawl fishery gear was the leading cause of serious injury and mortality for all phocids analyzed in Helker et al. (2019). As commercial fisheries adapt to changes in the location of commercially valuable fisheries, moving northward in the Bering Sea as a consequence of climate change, an increase in seal interactions with fisheries gear is likely.

5.3. Oil and Gas

Offshore petroleum exploration activities have been conducted in the action area both within State of Alaska waters and the Outer Continental Shelf (OCS) of the Beaufort and Chukchi seas, and nearby in Canada's eastern Beaufort Sea off the Mackenzie River Delta, in Canada's Arctic Islands, in the Russian Arctic, and around Sakhalin Island in the Sea of Okhotsk (NMFS 2016). In the central Beaufort Sea in Alaska, oil and gas exploration, development, and production activities include seismic surveys; geohazard surveys, geotechnical sampling programs; exploratory, delineation, and production drilling operations; construction of artificial islands, causeways, ice roads, shore-based facilities, and pipelines; and vessel and aircraft operations. Stressors associated with these activities that are of primary concern for marine mammals include noise, physical disturbance, and pollution, particularly in the event of a large oil spill.

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

Endicott Satellite Drilling Island, built in 1987, was constructed to support the first continuous production of oil from an offshore field in the Arctic. Subsequently, the Northstar offshore island was constructed in 1999 and 2000 to support oil production. Northstar, as well as the Nikaitchuq and Oooguruk developments, currently operate in nearshore areas of the Beaufort Sea, and are expected to continue operating in the future.

Offshore oil and gas development in Alaska poses a number of threats to listed marine species, including increased ocean noise, risk of hydrocarbon spills, production of waste liquids, habitat alteration, increased vessel traffic, and risk of ship strike. NMFS reviewed the potential effects of oil and gas development in a Final Environmental Impact Statement for the effects of oil and gas activities in the Arctic Ocean (NMFS 2013) and has conducted numerous Section 7 consultations on oil and gas activities in the Chukchi and Beaufort Seas (available at https://www.fisheries.noaa.gov/alaska/consultations/section-7-biological-opinions-issued-alaska-region). Increased oil and gas development in the U.S. Arctic has led to an increased risk of various forms of pollution to seal habitat, including oil spills, other pollutants, and nontoxic waste (Allen and Angliss 2015).

Many of the consultations have authorized the take (by harassment) of bowhead whales and bearded and ringed seals from sounds produced during geophysical (including seismic) surveys and drilling operations conducted by leaseholders during open water (i.e., summer) months. Geophysical seismic survey activity has been described as one of the loudest man-made underwater noise sources, with the potential to harass or harm marine mammals (Richardson et al. 1995). Controlled-source, deep-penetration reflection seismology, similar to sonar and echolocation, is the primary tool used for onshore and offshore oil exploration (Smith et al. 2017). The noise generated from seismic surveys has been linked to behavioral disturbance of wildlife, masking of cetacean communication, and potential auditory injury to marine mammals in the marine environment (Smith et al. 2017). Seismic surveys are often followed by test drilling. Test drilling involves fewer direct impacts than seismic exploration, but the potential risks of test drilling, such as oil spills, may have broader consequences (Smith et al. 2017).

5.3.1. Pollution and Discharges (Excluding Spills)

Previous development and discharges in portions of the action area are the source of multiple pollutants that may be bioavailable (i.e., may be taken up and absorbed by animals) to ESA-listed species or their prey items (NMFS 2013). Drill cuttings and fluids contain contaminants that have high potential for bioaccumulation, such as dibenzofuran and polycyclic aromatic hydrocarbons. Historically, drill cuttings and fluids have been discharged from oil and gas developments in the Beaufort Sea near the action area, and residues from historical discharges may be present in the affected environment (Brown et al. 2010). Polycyclic aromatic hydrocarbons are also emitted to the atmosphere by flaring waste gases at production platforms or gas treatment facilities. For example, approximately 162,000 million standard cubic feet of waste gas was flared at Northstar in 2004 (Neff 2010).

Marine mammals can ingest spilled compounds while feeding, inhale the volatile components, or be affected by direct contact. For example, whales can experience baleen fouling upon encountering petroleum products. Effects of oil ingestion on marine mammals can range from progressive organ damage to death, depending on the quantity and composition of the ingested oil (Geraci and St. Aubin 1990). Surface contact with oil spills can damage mucous membranes and eyes of seals, or disrupt thermoregulation in seal pups (Geraci and St. Aubin 1990).

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

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

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

The principal regulatory mechanism for controlling pollutant discharges from vessels (grey water, black water, coolant, bilge water, ballast, deck wash, etc.) into waters of the Arctic OCS is also the CWA. Discharges are covered under the Vessel Incidental Discharge Act, which is in the CWA Section 312(p)[10]. In addition, the U.S. Coast Guard has issued regulations that address pollution prevention with respect to discharges from vessels carrying oil, noxious liquid substances, garbage, municipal or commercial waste, and ballast water (33 CFR part 151). The State of Alaska regulates water quality standards within three miles of the shore.

5.3.2. Spills

BOEM and BSEE define small oil spills as <1,000 barrels (bbl). Large oil spills are defined as 1,000-150,000 bbl, and very large oil spills (VLOS) are defined as ≥ 150,000 bbl (BOEM 2017). Based on a review of potential discharges and on the historical oil spill occurrence data for the

[10] https://www.epa.gov/vessels-marinas-and-ports/vessel-incidental-discharge-act-vida

Alaska OCS and adjacent State of Alaska waters, several small spills in the Beaufort Sea from refueling operations (primarily at West Dock) were reported to the National Response Center. Small oil spills have occurred with routine frequency and are considered likely to occur (BOEM 2017).

In the past 30 years, 43 wells have been drilled in the Beaufort and Chukchi seas lease program areas. From 1995 to 2012, approximately 400 spills (100 to 300,000 gallons) occurred in Alaska's marine waters. Most were in nearshore and shallow coastal waters and were primarily diesel (BLM 2019). Only 1% of the spills were crude oil. If a pinniped came in direct contact with a small, refined oil spill it could experience inhalation and respiratory distress from hydrocarbon vapors, or ingestion directly or indirectly by consuming contaminated prey, and less likely skin and conjunctive tissue irritation (Engelhardt 1987). Oil may also foul pinniped pelage and be ingested during cleaning. Small offshore spills of refined petroleum products are expected to dissipate rapidly. A small spill could impact pinnipeds through their ingestion of contaminated prey, but prey contamination likely would be localized and temporary.

With respect to the ringed seals, small spills could result in irritation of the eyes, mouth, lungs, and anal and urogenetical surfaces (St. Aubin 1990). Immersion in crude oil could lead to kidney lesions and eye damage with longer exposure leading to more severe injuries (Geraci and Smith 1976). The effects of an oil spill on ringed seals would depend largely on the size, season, and location of the spill.

5.3.3. Contaminants

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

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

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

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

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 Utqiaġvik. Arsenic levels in ringed seals from Norton Sound were quite high for marine mammals, which might reflect localized natural arsenic sources.

5.4. Vessels

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

The number of unique vessels tracked via AIS in U.S. waters north of the Pribilof Islands increased from 120 in 2008 to 250 in 2012, and is expected to continue to increase (Azzara et al. 2015). This includes only the northern Bering Sea, the Bering Strait, Chukchi Sea and Beaufort Sea to the Canadian border. The increase in vessel traffic on the outer continental shelf of the Chukchi Sea and the near-shore waters off Prudhoe Bay from oil and gas exploration activity is particularly pronounced (ICCT 2015). The number of vessels identified in this region in 2012 includes a spike in vessel traffic associated with the offshore exploratory drilling program that was conducted by Shell on the outer continental shelf (OCS) of the Chukchi Sea that year. Overall, in 2012 there was a shift toward more offshore traffic, and there were also noticeable localized changes in vessel traffic concentration near Prudhoe Bay and in the vicinity of the drilling project in the Chukchi Sea (Azzara et al. 2015).

The U.S. Committee on the Marine Transportation System (CMTS) reported that the number of vessels operating in the Chukchi and Beaufort seas increased 128% from 2008 to 2018. The vessels include those used for research, natural resource exploration and extraction, commercial shipping, government/law enforcement/search and rescue, and tourism. Of the 255 vessels that transited through the US Arctic and surrounding region from 2015-2017, over 50% were tug, towing, and cargo vessels. Thirty-two flag states transited the region, although US flagged vessels were the most prevalent. The length of the navigation season has been growing by as much as 7-10 days annually, which, extrapolated over the next decade, could result in 2.5 months of additional navigation season over what was currently seen in 2019 (U.S. Committee on the Marine Transportation System 2019).

5.4.1. Vessel Noise

Vessel noise can create auditory interference, or masking, in which the noise can interfere with an animal's ability to understand, recognize, or even detect sounds of interest. This can lead to behavioral changes in marine mammals, such as increasing their communication sound levels or causing them to avoid noisy areas. Commercial shipping traffic is a major source of low frequency (5 to 500 Hz) human generated sound in the oceans (Simmonds and Hutchinson 1996, NRC 2003). The types of vessels operating in the Beaufort Sea typically include 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 a barges or other vessels. Other noise sources include onboard diesel generators and the main engine, but both are subordinate to propeller harmonics (Gray and Greeley 1980). Shipping sounds are often at source levels of 150 to 190 dB re 1 μPa at 1 m (BOEM 2011) with frequencies of 20 to 300 Hz (Greene and Moore 1995). Sound produced by smaller boats is typically at a higher frequency, around 300 Hz (Greene and Moore 1995). In shallow water, vessels more than 10 km (6.2 mi) away from a receiver generally contribute only to background-sound levels (Greene and Moore 1995). Noise from icebreakers comes from the ice physically breaking, the propeller cavitation of the vessel, and the "bubbler systems" that blow compressed air under the hull which moves ice out of the way of the ship. Broadband source levels for icebreaking operations are typically between 177 and 198 dB re 1 μPa at 1m (Greene and Moore 1995, Austin et al. 2015); however, they can be extremely variable mainly due to the varying thickness of ice that is being broken and the resulting horsepower required to break the ice.

5.4.2. Vessel Strikes

Current shipping activities in the Arctic pose varying levels of threats to marine mammals depending on the type and intensity of the shipping activity and its degree of spatial and temporal overlap with their habitats. The presence and movements of ships in the vicinity of seals can affect their normal behavior (Jansen et al. 2010) and may cause them to abandon their preferred breeding habitats in areas with high traffic (Smiley and Milne 1979, Mansfield 1983). To date, no bearded or ringed seal carcasses have been found with propeller marks. However, Sternfeld (2004) documented a single spotted seal stranding in Bristol Bay, Alaska, that may have resulted from a propeller strike.

Free-ranging marine mammals often engage in avoidance behavior when surface vessels move toward them. It is not clear whether these responses are caused by the physical presence of a surface vessel, the underwater noise generated by the vessel, or an interaction between the two (Goodwin and Cotton 2004, Lusseau 2006). These studies suggest that the behavioral responses of marine mammals to surface vessels are similar to their behavioral responses to predators. Increased vessel traffic resulting from a reduction in sea ice in the Arctic may lead to more vessel strike incidents in the future.

5.5. Ocean Noise

In addition to vessel noise described above, ESA-listed species in the action area are exposed to several other sources of natural and anthropogenic noise. Natural sources of underwater noise include sea ice, wind, waves, precipitation, and biological noise from marine mammals, fishes, and crustaceans. Other anthropogenic sources of underwater noise of concern to listed species in the action area include in-water construction activities such as drilling, dredging, and pile driving; oil, gas, and mineral exploration and extraction; Navy sonar and other military activities; geophysical seismic surveys; and ocean research activities. Levels of anthropogenic (human-caused) sound can vary dramatically depending on the season, type of activity, and local conditions. The combination of anthropogenic and natural noises contributes to the total noise at any one place and time. Noise impacts to listed marine mammal species from many of these activities are mitigated through ESA Section 7 consultations.

Noise is of particular concern to marine mammals because many species use sound as a primary sense for navigating, finding prey, avoiding predators, and communicating with other individuals. As described in greater detail later in this opinion, noise may cause marine mammals to leave a habitat, impair their ability to communicate, reduce their survival rate, or cause stress. Noise can cause behavioral disturbances, can mask other sounds, including their own vocalizations, may result in injury, and, in some cases, may result in behaviors that ultimately lead to death. The severity of these impacts can vary greatly between minor impacts that have no real cost to the animal, to more severe impacts that may have lasting consequences.

Because responses to anthropogenic noise vary among species and individuals within species, it is difficult to determine long-term effects. Habitat abandonment due to anthropogenic noise exposure has been found in terrestrial species (Francis and Barber 2013). The presence and movements of ships in the vicinity of seals can affect their normal behavior (Jansen et al. 2010) and may cause them to abandon their preferred breeding habitats in areas with high traffic (Sullivan 1980, Allen 1984, Henry and Hammill 2001, Edrén et al. 2010, London et al. 2012).

Because noise is a primary source of disturbance to marine mammals, and the category of disturbance most focused on in Incidental Harassment Authorizations and Letters of Authorization, this opinion considers it as a separate category of the Environmental Baseline.

5.5.1. Ambient Noise

Ambient sound, as it is considered here, refers to naturally produced sound in the absence of measurable anthropogenic sound. Ambient sound is different from “background sound” which can include anthropogenic sounds that are typical for a particular location.

The presence of ice can contribute significantly to ambient sound levels and affects sound propagation. While sea ice can produce substantial amounts of ambient sounds, it also can function to dampen or heighten ambient sound. Smooth annual ice can enhance sound propagation compared to open water conditions (Richardson et al. 1995). However, with increased cracking, ridging, and other forms of sub-surface deformation, transmission losses generally become higher compared to open water (Richardson et al. 1995, Blackwell and Greene 2001). Urick (1996) discussed variability of ambient noise in water, including under Arctic ice. He stated that “the ambient background depends upon the nature of ice, whether continuous, broken, moving or ground-fast, the temperature of air, and the speed of the wind.” Temperature affects the mechanical properties of the ice, and temperature changes can result in cracking. The spectrum of cracking ice sounds typically displays a broad range from 100 Hz to 1 kHz, and the spectrum level has been observed to vary as much as 15 dB re 1 μPa at 1 m within 24 hours due to diurnal variability in air temperatures (BOEM 2011). Data are limited, but in at least one instance it has been shown that ice-deformation sounds produced frequencies of 4 to 200 Hz (Greene 1981).

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

There are many marine mammals in the Arctic marine environment whose vocalizations contribute to ambient sound including bowhead whales, gray whales, beluga whales, walrus, ringed seals, bearded seals, and spotted seals. Ringed seal calls have a source level of 95 to 130 dB re 1 μPa at 1 m, with the dominant frequency under 5 kHz (Cummings et al. 1986, Thomson and Richardson 1995).

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

As discussed in section 5.3, NMFS has conducted numerous ESA section 7 consultations related to oil and gas activities in the Beaufort Sea. Many of the consultations have and estimated take of ringed seals from sounds produced during geophysical (including seismic) surveys and other exploration and development activities. From 2014-2021, 26,729 Level B takes of ringed seals were authorized and 3,079 takes were recorded as having occurred based on monitoring reports, for oil and gas projects in the Arctic. These numbers indicate actual take was 11.5 percent of what was estimated to occur and authorized. All takes were Level B harassment takes which likely resulted in a behavioral reaction to sound and did not lead to harm or injury to the animals.

5.5.3. Aircraft Noise

In a study examining responses of ringed seals to anthropogenic noise, Kelly et al. (1988) found their response to helicopters to be variable. Responses to take offs and landings were noted six times with seals departing on two occasions when the helicopters were at one and three kilometers. On four occasions, all at distances greater than 2.5 km the seals remained in their lairs. Seals departed lairs in five of 14 cases in response to airborne helicopters. Tolerance of helicopters varied with some seals leaving its lair when the helicopter was 5 km away at an altitude of 152 m and others tolerating helicopters 0.6 km away at an altitude of 122 and directly overhead at 762 m (Kelly et al. 1988). We note observations of helicopter response was opportunistic as the primary purpose of the study was to document the response of seals to seismic surveys and island building. Over 700 seal lairs were observed across the four years of the study; the observed response to helicopters represents a limited picture of the ringed seal response and many seals may have remained in their lairs and were never spotted. Ringed seals are most adversely affected by noise disturbance in late March through June when they spend greater amounts of time out of the water and their movements are limited to small areas due to their dependent offspring (Kelly et al. 1988). One study indicated that the risk of flushing ringed seals into the water can be substantially reduced if small-type helicopters do not approach closer than 1500 m and small fixed-wing aircraft do not approach closer than 500 m (Born et al. 1999).

5.6. Direct Mortality

Within the proposed action area there are two primary sources of direct mortality of ringed seals: subsistence harvest and predation. Direct mortality associated with vessels strikes is addressed in Section 5.4.2.

5.6.1. Subsistence Harvest

The ESA and MMPA allow for the harvest of marine mammals by Alaska Natives for subsistence purposes and for the creation of traditional handicrafts.

Ringed seals are important subsistence species for many northern coastal communities. Approximately 64 Alaska Native communities in western and northern Alaska, from Bristol Bay to the Beaufort Sea, regularly harvest ringed and bearded seals for subsistence purposes (Ice Seal Committee 2019). Estimates of subsistence harvest of ringed seals are available for several of these communities based on annual household surveys (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. From 2012-2017, only 4 percent (3 of 64) of the coastal communities that harvest ice seals have been surveyed in two or more consecutive years (Ice Seal Committee 2019). Household surveys are designed to estimate harvest for the specific community surveyed; extrapolation of harvest estimates beyond a specific community is not appropriate because of local differences in seal availability, cultural hunting practices, and environmental conditions (Ice Seal Committee 2019). From 2013 through 2017, the total annual ringed seal harvest estimates across surveyed communities ranged from 185 to 1,306 (Table 6).

Table 6. Alaska ringed seal harvest estimates based on household surveys in selected communities, 2013–2017

Community	Estimated Ringed Seal Harvest				
	2013	2014	2015	2016	2017
Nuiqsut	-	58	-	-	-
Utqiaġvik	-	428	-	-	-
Point Hope	-	246	-	-	-
Kotzebue	-	69	-	-	-
Shishmaref	-	296	-	-	-
Hooper Bay	667	158	185	546	193
Tununak	-	-	-	117	-
Tuntutuliak	75	-	-	-	-
Quinhagak	160	51	-	26	-
Total	**902**	**1,306**	**185**	**689**	**193**

5.6.2. Predation

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

Polar bear predation on ringed seal pups tripled when pups were prematurely exposed as a consequence of unseasonably warm conditions. Hammill and Smith (1991) further noted that polar bear predation on ringed seal pups increased four-fold when average snow depths in their study area decreased from 23 cm to 10 cm. 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 (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 (Kelly et al. 2010b).

5.7. Plastics

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

5.8. Other Arctic Projects

In the winters of 2014, 2016, 2018, and 2020 the U.S. Navy conducted similar submarine training, testing, and other research activities in the northern Beaufort Sea and Arctic Ocean from a temporary camp constructed on an ice flow. As with this project, equipment, materials, and personnel were transported to and from the ice camp via daily flights based out of the Deadhorse Airport (located in Prudhoe Bay). An IHA was first requested and issued to the U.S. Navy to incidentally harass (level B only) marine mammals for these activities in 2020. Take of 1,406 ringed seals was authorized. No seals were sighted or heard during the project.

In 2021, two projects received IHAs for activities in the Beaufort Sea and both projects received biological opinions from NMFS. The National Science Foundation conducted a low and high energy marine seismic survey in the Arctic Ocean in August and September. The purpose of the project was to provide data so the northern edge of the Chukchi Borderland and the adjacent Canadian Basin could be mapped. The second project was conducted by the Office of Naval Research (ONR) in the Beaufort Sea in October. ONR deployed a variety of scientific instruments and unmanned undersea vehicle to determine if data on environmental conditions could be collected year-around, to test various underwater navigational systems, and to test the use of very low frequency technology.

An IHA was issued to the Alaska Gasline Development Corporation to harass marine mammals during pile driving associated with the Alaska LNG project in Prudhoe Bay from July 2022 through June 2023. In the ESA section 7 consultation for this project, estimates of Level A takes of ESA-listed animals associated with this project include 32 ringed seals and 5 spotted seals. Estimates of Level B takes of ESA-listed animals associated with this project include 1,765 ringed seals. This project has not yet commenced.

5.9. Scientific Research

Research is a necessary endeavor to assist in the recovery of threatened and endangered species; however, research activities can also disturb these animals. Research on marine mammals often requires boats, adding incrementally to the vessel traffic, noise, and pollution in the action area. Deployment and retrieval of passive acoustic monitoring devices requires a boat, which temporarily increases noise in the immediate area. However, once the instruments are deployed, passive acoustic monitoring is noninvasive.

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

Of the more than 30 active scientific research permits, some include behavioral observations, counting/surveying, photo-identification, and capture and restraint (by hand, net, cage, or board), for the purposes of performing the following: collection of blood, clipped hair, urine and feces, nasal and oral swabs, vibrissae (pulled), skin, blubber, or muscle biopsies, weight and body measurements, injection of sedatives, administration of drugs (intramuscular, subcutaneous, or topical), attachment of instruments to hair or flippers, including flipper tagging, ultrasound

These activities may cause stress to individuals and cause behavioral responses. In some cases, take could occur and is authorized by the research permits.

6. Effects of the Action

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

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

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

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

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

6.1. Project Stressors

Stressors are any physical, chemical or biological phenomena that can induce an adverse response. The effects section starts with identification of the stressors produced by the constituent parts of the proposed action. The proposed activities will expose ringed seals to the sounds and physical presence of aircraft, snow machines and other on-ice vehicles, ice auguring, activities at the ice camp, torpedoes launched from the submarines, sonar used by the submarines, and passive sound sources.

Based on our review of the project activities, the proposed activities may cause the following stressors:

1. Sound field produced by active transmissions from submarine
2. Sound fields produced by continuous noise sources such as aircraft, snow machines and other on-ice vehicles, ice auguring, and scientific devices
3. On-ice vehicle strike
4. In-water submarine, torpedo, or unmanned vehicle strike
5. Human presence
6. Entanglement
7. Pollution

Of these, number 1 is a major stressor that is likely to result in take of ringed seals by harassment, and numbers 2-7 are minor stressors that are unlikely to result in take.

6.1.1. Minor Stressors on ESA-Listed Species and Critical Habitat

6.1.1.1. Aircraft noise

Ringed seals may react to the sound of an aircraft or to its physical presence flying overhead, or both. During February through April, when the fixed-wing and helicopter flights associated with the proposed action will occur, ringed seals may be on the ice, in the water, or within their subnivean lairs. Ringed seals that are hauled out may react to the noise or visual stimulus by looking up at the aircraft, moving on the ice, entering a breathing hole or crack in the ice, or entering the water (Blackwell et al. 2004, Born et al. 2004). Reactions depend on several factors including the animal's behavioral state, activity, group size, habitat, the flight pattern of the aircraft, and local environmental conditions (noise is muffled on windy cloudy days, louder on clear calm days) (Richardson et al. 1995). Additionally, a study conducted by Born et al. (1999) found that wind chill was also a factor in level of response of ringed seals hauled out on ice (higher wind chill increases probability of leaving the ice), as well as time of day and wind direction. Ringed seal reactions to helicopter disturbance are difficult to predict, though helicopters have been recorded to elicit a stronger behavioral response than a fixed-wing aircraft (Burns and Frost 1979, Born et al. 1999).

The responses of ringed seals in subnivean lairs are typically stronger than that of a basking ringed seal (Burns et al. 1982). Ringed seal vocalizations in water were similar between areas subject to low-flying aircraft and areas that were less disturbed (Calvert and Stirling 1985). These data suggest that although a ringed seal may leave a subnivean lair, aircraft disturbance does not cause the animals to leave the general area. Additionally, ringed seals construct multiple breathing holes and lairs within their home ranges (Smith and Stirling 1975); these additional lairs and breathing holes are used as escape lairs from predators, and therefore could be a suitable alternative in the event they leave a lair directly below the flightpath of an aircraft.

During the proposed action, small, fixed-wing aircraft (the most frequently used aircraft) could operate at altitudes up to 3,500 m but will maintain an altitude of at least 305 m. At this altitude, the footprint of airborne noise at the ice surface would be an approximately 2 km^2 area which would move along the flight path of the aircraft. Due to the relatively small area over which aircraft noise would radiate outward, the noise would be transient (a maximum duration of about 15 seconds, assuming a flight speed of 120 kts). As received sound levels would be reduced by the time the sound reaches the ice from an overhead flight (attenuating in the air column) and would still have to travel through the ice, underwater noise would be brief in duration, of reduced intensity, and would transfer to water along a narrow swath.

Helicopter flights associated with the proposed action are used for logistical purposes (transport of personnel and equipment) and logistical training purposes (military pilots gaining proficiency in transporting equipment) and are not conducting typical training or testing; therefore, helicopters would not be hovering or flying a route pattern for an extended period. Helicopters produce low frequency sound (Richardson et al. 1995, Pepper et al. 2003) and contain dominant tones from the rotors that are generally below 500 Hz. Noise generated from helicopters is transient in nature and variable in intensity. Helicopters often radiate more sound forward than aft. The underwater noise produced is generally brief when compared with the duration of audibility in the air. Rotary-wing aircraft tend to be noisier than similar-sized fixed wing aircraft.

The intermittent use of fixed-wing aircraft and helicopters, the short-term impacts of any behavioral reactions from aircraft activities, and the implementation of the mitigation measures which will maintain distance between seals and the aircraft will greatly reduce the potential for adverse impacts to ringed seals. In addition, ICEX2022 activities will largely be concluded by the end of March before seals in lairs become more sensitive to disturbance. For these reasons we conclude that the impact of aircraft sound is very minor, adverse effects to ringed seals will be brief and of very low intensity, and any reactions by the seals are expected to be imperceptible or very brief. Therefore, we conclude that adverse effects from aircraft traffic will be minimal or undetectable.

Two unmanned aerial systems (UAS) would be utilized during ICEX2022. The rotary-wing unmanned aerial system operates in a similar manner as helicopters, but on a smaller scale. Based on a study by Christiansen et al. (2016), an initial analysis of underwater recordings at 1 m below the water surface of noise produced by a rotary-wing UAS was only detectable above ambient noise when the system was flown at altitudes lower than 10 m. Though the study found that in-air recordings showed that the noise levels produced by the UAS were within noise-level ranges known to cause disturbance in some marine mammals, the in-water received noise levels at 1 m depth were orders of magnitude below those shown to cause any direct damage on auditory systems or compromise physiology in marine mammals (Southall et al. 2007, Christiansen et al. 2016). The UAS that will be used will not hover over marine mammals in accordance with the mitigation measures, and will fly at an altitude of at least 15 m. The impacts of these devices will be very minor, and adverse effects to ringed seals, especially ringed seals within subnivean lairs, are expected to be immeasurably small, if they occur at all. Therefore, we conclude that adverse effects from UAS on ringed seals will be minimal or undetectable.

6.1.1.2. On-Ice Vehicle Noise

The use of on-ice vehicles is integral to ice camp logistics (e.g., personnel and equipment transport) and to the completion of many research objectives. Small snow machines create sounds at higher frequencies than larger, slower machinery. The sound level associated with snow machines is dependent upon the model, engine size, and speed driven. In addition, noise levels are affected by the ice condition, amount of snow on the ice, wind, and other similar factors (Richardson et al. 1991), making precise predictions of the noise transmitted difficult.

Snowmobiles produce sound at source levels of 104 dBA on average (Richardson et al. 1995). Generally, two- and four-stroke snowmobiles traveling at approximately 32 kilometers per hour (km/hr) had a resultant average sound level of 66–71 dBA re 20 μPa at 15 m. At higher speeds of approximately 64 km/hr, the average sound level increased to 73–75 dBA re 20 μPa at 15 m. During acceleration, the highest sound level was recorded as 80.2 dBA re 20 μPa at 15 m. As reported in Malme et al. (1989), the under-ice sound pressure level for a snowmobile driving 16 km/hr is 124 dB re 1 μPa at a frequency of 1.6 kHz. While this is well within the hearing range of phocids underwater, Kvadsheim et al. (2010) noted that hooded seals did not react to sounds at this frequency and decibel sound level. In addition, at 100 m (mitigation distance) the received sound levels would be well below the 100 dB re 20 µPa $_{rms}$ threshold considered to cause Level B behavioral disturbance for non-harbor seal pinnipeds (*see* MMPA section 3(18)(A)(ii)).

To the extent possible, the location for the ice camp will be selected to avoid pressure ridges and snow drifts to facilitate ease in camp construction, logistics, and aircraft landing safety. Any seals with lairs in the vicinity of the ice camp would likely move to a new lair during the gradual establishment of the camp prior to being subject to higher levels of activity once the camp is fully operational. If, after the ice camp is established, a new pressure ridge forms nearby, it is unlikely that a ringed seal would construct a lair in the area near the ice camp. During excursions away from the ice camp (e.g., to deploy research equipment), on-ice vehicles would use the same routes once routes are established. Use of the same route would minimize the number of subnivean lairs potentially exposed to on-ice vehicle noise as the routes would be established avoiding any pressure ridges, and it is not expected that a ringed seal would create a lair in the vicinity of a snowmobile route once the route is established. Seal pups are not anticipated to be in the vicinity of the ice camp during operations, because breeding females are not expected to whelp within the camp's disturbance zone, and whelping is not expected prior to initiation of camp construction in February.

Because of the selection of the camp location to avoid pressure ridges and potential ringed seal habitat, the use of established snow machine routes, the high likelihood that ringed seal presence in the area is extremely low, the low received sound levels, and the low likelihood that noise from the snow machines will disturb seals either on the ice or under the ice, we conclude that ringed seal responses to noise associated with on-ice vehicles is not likely to result in significant disruption of feeding, breeding or other natural behavioral patterns. If there were a reaction from noise produced by snow machines or other on-ice vehicles, it would be expected to be extremely minor.

6.1.1.3. Ice Auguring

Ten holes will be augured in the ice for the deployment of hydrophones in the vicinity of the ice camp. In addition, one hole will be augured to drain gray water from the dining hall and one hole will be drilled for the desalinization equipment. Greene et al. (2008) recorded underwater noise from an ice auger during ice road construction at the Northstar Development (Beaufort Sea) and found noise levels at the source were below 100 dB re 1µPa. These levels are below the behavioral threshold for underwater noise harassment for seals. Ringed seals that are out of the water in February through April are expected to be in lairs. Airborne sounds would be greatly attenuated by the ice and snow. The area disturbed by drilling holes in the ice is extremely small. Background noise from wind and movements of the ice are expected to be louder and more consistent than the short duration noise created by ice augering. For these reasons the effects of ice augering on ringed seals is expected to be extremely unlikely.

6.1.1.4. On-Ice Vehicle Strike

Four to six snow machines would be used for personnel and equipment transport, as well as supporting research activities away from the ice camp. Dependent on the type of equipment and supplies to be transported, the snowmobiles may tow a sled to accommodate the items. Additionally, small unit support vehicles may be used to establish the runway for fixed-wing aircraft landings. An all-terrain tracked vehicle may be used by expeditionary forces to transport forces to and from the ice camp. Snowmobile excursions away from the ice camp would support various research activities during the height of the proposed action (for a period of approximately four weeks). Some excursions away from the ice camp may last up to six hours, while shorter trips would only last one to two hours. Snow machines would not be in constant use during these trips; they would transport personnel and equipment to an offsite location (generally up to 5 km from camp) and then stand by until the experiment is complete before returning the personnel to the camp. Additionally, personnel movement on snowmobiles, small unit support vehicles, and all-terrain tracked vehicles both away from and around camp would only occur during daylight hours, which would further reduce the potential for striking an exposed ringed seal.

During the timeframe of the proposed activities, it is highly unlikely that ringed seals would be basking on the surface of the ice as the molting period does not begin until mid-April (Figure 9). Kelly et al. (1986) tagged ringed seals from Reindeer Island and Kotzebue Sound off the coast of Alaska, in the Beaufort and Chukchi Sea, respectively. The tagged ringed seals spent between 3.5 and 30.8 percent of the time out of the water during the pre-basking period. Time spent out of the water during this period was only spent in lairs and not on the open sea ice.

Snow machine routes will be selected to avoid pressure ridges, and once established, snow machine routes will be re-used. Under the proposed action's mitigation measures, all snow machine expeditions will have a dedicated observer looking for marine mammals and any ringed seal observed would be avoided by 100 m. Additionally, snowmobiles and all-terrain vehicles are highly mobile and would move easily to avoid any ringed seal spotted nearby. The risk of collision is further reduced by a ringed seal's moving away from of any vehicle making noise before the vehicle approaches closely. For these reasons, the likelihood of an on-ice vehicle strike would be exceedingly remote.

6.1.1.5. In-Water Vessel and Vehicle Strike

Submarines, torpedoes, and underwater vehicles that would be utilized during ICEX2022 have the potential to result in strike to ringed seals. Unmanned underwater vehicles are slow moving, typically less than 8 knots. In-water vessels and vehicles would operate at a maximum depth of 800 m during the proposed action. The torpedoes do not launch from the submarine with a loud percussive sound, rather they swim away. Combustion by-products are formed (discussed under 6.1.1.8 Pollution) from the submarine motor and not from an explosion. The torpedo's motor is programmed to increase speed. It is not capable of sensing and avoiding a seal, however, it also is not moving so fast that a seal would be unable to evade it. A seal should have enough time to sense the torpedo moving through the water column and swim out of the way to avoid collision. The very low density of ringed seals in the action area at the time of ICEX 2022 makes the probability of a torpedo striking a ringed seal extremely small. Research on animal reactions to submerged submarines and unmanned underwater vehicles has not been conducted; the discussion below is based on potential reactions to boats, which is used as a surrogate for this analysis.

Vessels have the potential to affect ringed seals by eliciting a behavioral response or causing mortality or serious injury from collisions. It is difficult to differentiate between behavioral responses to vessel sound and visual cues associated with the presence of a vessel (Richardson et al. 1995); thus, it is assumed that both play a role in prompting reactions from animals. Reactions to vessels often include changes in general activity (e.g. from resting or feeding to active avoidance), changes in surfacing-respiration-dive cycles, and changes in speed and direction of movement. Past experiences of the animals with vessels are important in determining the degree and type of response elicited from an animal-vessel encounter. Some species have been noted to tolerate slow-moving vessels within several hundred meters, especially when the vessel is not directed toward the animal and when there are no sudden changes in direction or engine speed (Richardson et al. 1995, Heide-Jørgensen et al. 2003).

Ringed seals react to vessels in a variety of ways. Some respond by retreating or engaging in antagonistic responses, while other animals ignore the stimulus altogether (Watkins 1986). The size of a vessel and speed of travel affect the likelihood of a collision. Reviews of stranding and collision records indicate that larger surface ships (80 m or larger) and ships traveling at or above 14 knots have a much higher instance of collisions with marine mammals that result in mortality or serious injury (Laist et al. 2001). The depths at which the submarines and unmanned underwater vehicles operate would overlap with known dive depths of ringed seals, which have been recorded to 300 m in depth (Lydersen 1991, Gjertz et al. 2000). For most of the training and testing activities during the proposed action, vessel and vehicle speeds would not exceed 10 knots during the time spent within the study area, which would lessen the likelihood of collisions with ringed seals. Additionally, as part of the Navy's standard operating procedures, personnel will be passively listening for marine mammals during marine training and testing activities, thereby further reducing the possibility of ship strike.

Submarines and unmanned underwater vehicles are not expected to elicit an anti-predator response in a ringed seal. The primary predator to the ringed seal is the polar bear. Submarines are much larger than the natural predators to the ringed seal, and it would not be likely a submarine would cause a ringed seal to have an antipredator response. Although unmanned underwater vehicles and torpedoes are much smaller than a submarine, the movement patterns of these vehicles would not resemble the swimming pattern of a polar bear, and they would be underwater not on the surface where polar bears swim. Therefore, they are very unlikely to result in an anti-predator reactions. To date, no ringed seal carcasses have been found with propeller marks. However, Sternfeld (2004) documented a single spotted seal stranding in Bristol Bay, Alaska, that may have resulted from a propeller strike.

Considering the very low density of animals that may be present in the action area, the fact that the vessels will typically be traveling less than 10 knots, ringed seals are highly maneuverable, and none of the vessels will resemble a predator, we conclude that vessel strike is extremely unlikely and that the normal activities of ringed seals will not be measurably disrupted by vessel activity.

6.1.1.6. Human Presence

The construction of the ice camp and associated human presence could potentially cause ringed seals to leave an established lair or breathing hole. However, ringed seals typically build several lairs and breathing holes, and are assumed to be readily able to move to another lair or breathing hole within their home range (Kelly 1988a). The ice camp location would be selected, in part, to avoid areas near pressure ridges where ringed seals may build their subnivean lairs. If the ice camp were near a subnivean lair or breathing hole, it could cause ringed seals to evacuate the lair or leave their breathing hole. Although ringed seals may abandon their subnivean lair or breathing hole, the population effect would most likely be minor since ringed seals are assumed to be readily able to move to different areas under the ice (Kelly 1988b). It is anticipated that construction of the camp would be completed prior to whelping. As such, pups are not anticipated to be in the vicinity of the camp at the commencement of the exercises, and therefore mothers would not need to move newborn pups due to construction noise from camp.

Human presence could potentially affect ringed seals within the water column during diving evolutions as part of the research objectives to measure personnel and equipment proficiency and to recover torpedoes. Few divers would be in the water at any given time; diving activities would occur over a couple of weeks, with various personnel and equipment tested during this time. Data are not available on ringed seal reactions to humans in water; however, they would likely exhibit an avoidance response to the perceived predatory threat. This could result in a very short-term and localized behavioral response by the ringed seals in the immediate area of the diving activity.

Because of the low density of ringed seals in the action area, the very limited time period over which human presence will potentially intersect with ringed seals, and because of standard operating procedures and mitigation measures which are designed to minimize the impact of human activities on marine mammals, human presence is unlikely to adversely impact ringed seals.

6.1.1.7. Entanglement

We expect entanglement of ringed seals in the hydrophone lines will be highly unlikely as the lines will be kept taut from their anchor attachments, reducing the risk of entanglement. The hydrophones, buoys, and acoustic array lines would have weights attached so that no loops or slack in the lines are anticipated. When the camp is active, the likelihood of entanglement will be further reduced because personnel will be monitoring for the presence of marine mammals under the proposed mitigation measures and will be aware of their presence in the area. Scientific instruments with cables are not going to be left behind.

Although there is a potential for entanglement from an expended material, the amount of material is expectedly to be extremely low to none. Accidental loss of equipment could occur and although every effort is made to maintain a clean camp, wind could randomly pick up trash and blow it offsite, eventually to end up in the water. Although northern fur seals have become entangled with discarded fishing gear and plastic strapping in the Bering Sea (Laist 1997, Savage 2019), we have no reports of ringed seals becoming entangled in any type of material. Therefore, based on the lack of evidence of previous ringed seal entanglements in this region and the very low amount of project materials capable of causing entanglement, the probability of ringed seals becoming entangled in project-related materials is extremely small, and thus adverse effects to the seals are extremely unlikely.

6.1.1.8. Pollution

The air-drop of equipment and material poses some potential risk, particularly from the drop of fuel drums. Fuel may be dropped in bundles of five 55-gallon drums from a military cargo aircraft (e.g., C-130 or C-17). Military aircrews are highly trained in this activity and routinely drop equipment and supplies, including fuel, in expeditionary environments across the globe (including environments similar to the Arctic such as Greenland and Antarctica) without incident. The air drop bundles are made of several layers of a plywood structure with honeycomb insulation protecting the drums. Air-drop of material would occur only after initial construction of the camp has begun and personnel are available to respond to any potential rupture with proper spill containment procedures.

Under the Navy's standard operating procedures, all air-drop of materials would include the use of a parachute meant to stabilize the fall and slow the load so that it impacts the ice with minimal force. Equipment and material that may be air-dropped to the camp includes construction material, food, vehicles, and fuel. A worst-case scenario would be that a parachute fails to open for a single load of fuel (five 55-gallon drums), in which case 275 gallons of fuel could be released to the ice. The likelihood of this worst-case scenario occurring is extremely remote because, although ruptures have occurred, they are very infrequent (Navy 2019). Even in the case of a parachute failure, typically only one or two barrels would be dented or possibly ruptured. In the event of a fuel drum rupture, personnel would be standing by with applicable spill control measures and spill kits (e.g., absorbent materials) to remove any spilled fuel from the ice floe. Snow and ice cover that become contaminated would be collected and removed from the ice floe to the greatest extent practicable. All personnel would have oil spill response training, and oil spill response and reporting procedures would be followed.

In addition to a rupture from air-dropped fuel, refueling activities at the camp (e.g., for snowmobiles and generators) could result in small spills. Camp activities such as snowmobile refueling and generator refueling will temporarily increase the risk of accidental fuel and lubricant spills. Accidental spills may occur from a spilled container, vessel leak, or air dropped container. However, the standard operating procedures which includes training of personnel, hazardous waste clean-up supplies, and measures to contain spills that may occur (i.e. containment trays), and protective packing, will minimize probability and extent of any spills. In addition, only small volumes of fuel would be present on the ice flow. Adverse impacts to the seals are therefore extremely unlikely.

Because all human waste will be removed from the ice floe, and flown back to land and properly disposed, no pollution is expected from human waste. In addition, environmentally appropriate soap will be used in the galley, there will be no shower facilities, food waste will be minimized through the use of prepared meals, and gray water will be screened so that only small particles less than 16 mm will pass through. Up to 195 gallons of graywater could be discharged daily during the two weeks of peak camp operations. Saline water approximately three times more saline than the receiving water will be discharged from the camp as the result of desalinization. It is estimated that just over 8,000 gallons (about 140 gallons per day) of saline water will be discharged over the time frame of ICEX 2022. This water will be diluted and mixed in the receiving water. The amount of water to be discharged is insignificant compared to the volume of receiving water, and is expected to be diluted to unharmful concentrations rapidly (on the order of minutes), and thus is not anticipated to have any impact on ringed seals. Through these standard operating procedures, adverse impacts to seals are extremely unlikely to occur.

Chemicals that could be released from exercise torpedoes as a result of the proposed action are Otto Fuel II and combustion byproducts. Properly functioning torpedo runs combust most of their propellants, leaving benign or readily diluted soluble combustion byproducts. Otto Fuel II is composed of propylene glycol dinitrate and nitro-diphenylamine (76 percent), dibutyl sebacate (23 percent) and 2-nitrodiphenylamine as a stabilizer (2 percent). Combustion byproducts of Otto Fuel II include nitrous oxides, carbon monoxide, carbon dioxide, hydrogen, nitrogen, methane, ammonia, and hydrogen cyanide. During normal venting of excess pressure, the following are discharged: carbon dioxide, water, hydrogen, nitrogen, carbon monoxide, methane, ammonia, hydrochloric acid, hydrogen cyanide, formaldehyde, potassium chloride, ferrous oxide, potassium hydroxide, and potassium carbonate (U.S. Department of the Navy 1996, 1997).

Hydrogen cyanide would be the constituent of most concern because initial concentrations following a torpedo run would be above EPA discharge recommendations for marine waters (3.785 mg/gal) (U.S. Environmental Protection Agency 2006). Other combustion byproducts from Otto Fuel II released into the ocean would dissolve, dissociate, or be dispersed and diluted into the water column. However, hydrogen cyanide is extremely soluble in seawater and would rapidly be diluted to levels below 3.785 mg/gal (within a distance of 5.4 m from the center of the torpedo's path when first discharged). The Navy has determined that five types of common marine bacteria (*Pseudomonas*, *Flavobacterium*, *Vibrio*, *Achromobacter*, and *Arthrobacter*) attack and ultimately process Otto Fuel II, thereby removing trace amounts that may remain (Navy 2021a)

Potential harm to ringed seals from the release of combustion byproducts would depend on the amount of harmful substances remaining in the water following the torpedo run. Properly functioning torpedoes combust most of their propellants, leaving benign or readily diluted soluble combustion byproducts (e.g., hydrogen cyanide). Operational failures allow release of propellants and their degradation products into the marine environment. Torpedo propellant poses little risk to ringed seals because the chemicals have relatively low toxicity. Ringed seals can also readily vacate the area and are less susceptible to potential harm from chemical releases. Ringed seals may be exposed by contact with chemical contaminants in the water. However, we would expect that combustion byproducts would be diluted rapidly and doses large enough to have detectable effects would be extremely unlikely.

6.1.2. Major Stressors on ESA-Listed Species and Critical Habitat

The following sections analyze the stressors likely to adversely affect the ringed seal due to underwater sounds created by active transmissions from the submarines. The submarine training and research activities have acoustic transmissions with potential effects to ringed seals. Some acoustic sources are either above the known hearing range of marine species or have narrow beam widths and short pulse lengths that affect a very small area of water for a very short amount of time and are therefore extremely unlikely to affect marine mammals that are present at low densities in the action area. Submarine training and testing, which are proposed to occur over a two-week period, are the only portions of the proposed action with active acoustics that require quantitative analysis. All other equipment and devices to be used will have *de minimis* effects which means they have low source levels, narrow beams, downward directed transmission, short pulse lengths, frequencies outside known marine mammal hearing ranges, or some combination of these factors (Navy 2021a). Effects to seals swimming underwater are the primary concern regarding this active transmission, because the sound levels received by hauled out seals will be much lower, due to transmission loss through the ice and air.

First, we provide a brief explanation of the sound measurements and acoustic thresholds used in the discussions of acoustic effects in this opinion.

6.1.2.1. Acoustic Thresholds

Since 1997, NMFS has used generic sound exposure thresholds to determine whether an activity produces underwater and in-air sounds that might result in impacts to marine mammals (70 FR 1871, 1872; January 11, 2005). NMFS has developed comprehensive guidance on sound levels likely to cause injury to marine mammals through onset of permanent and temporary thresholds shifts (PTS and TTS) (83 FR 28824; June 21, 2018; 81 FR 51693; August 4, 2016). NMFS is in the process of developing guidance for behavioral disruption (Level B harassment). However, until such guidance is available, NMFS uses the following conservative thresholds of underwater sound pressure levels,[11] expressed in root mean square[12] (rms), from broadband sounds that cause behavioral disturbance, and referred to as Level B harassment under section 3(18)(A)(ii) of the MMPA (16 U.S.C § 1362(18)(A)(ii)):

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

Under the PTS/TTS Technical Guidance, NMFS uses the following thresholds (Table 3) 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.

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

Hearing Group	ESA-listed Marine Mammals In the Project Area	Generalized Hearing Range[1]
Phocid pinnipeds (PW) *(true seals)*	Ringed and bearded seals	50 Hz to 86 kHz
[1]Respresents the generalized hearing range for the entire group as a composite (i.e., all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on ~65 db threshold from normalized composite audiogram, with the exception for lower limits for PW pinniped (approximation).		

These acoustic thresholds are presented using dual metrics of cumulative sound exposure level

[11] 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.

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

(L_E) and peak sound level (PK) for impulsive sounds and L_E for non-impulsive sounds.

Level A harassment radii can be calculated using the optional user spreadsheet[13] associated with NMFS Acoustic Guidance, or through modeling.

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

Hearing Group	**PTS Onset Acoustic Thresholds*** **(Received Level)**	
	Impulsive	**Non-impulsive**
Phocid Pinnipeds (PW) (Underwater)	$L_{pk,flat}$: 218 dB $L_{E,PW,24h}$: 185 dB	$L_{E,PW,24h}$: 201 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.

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 (16 U.S.C § 1362(18)(A)(ii)):

- 100 dB_{rms} re 20μPa for non-harbor seal pinnipeds

There is no established in-air acoustic threshold for Level A injury. For the proposed action, in-air acoustic disturbance could be caused by aircraft or ice auguring. These affects are discussed in sections 6.1.1.1 and 6.1.1.3, respectively.

The National Defense Authorization Act of Fiscal Year 2004 (PL 108-136) amended the definition of "harassment" under the MMPA, specifically as it applies to military readiness activities or scientific research activities conducted by or on behalf of the federal government (16 U.S.C. §1362 (18)(B)). The Fiscal Year 2004 National Defense Authorization Act adopted the definition of "military readiness activity" as set forth in the Fiscal Year 2003 National Defense Authorization Act (PL 107-314). Research activities within the study area are composed of military readiness activities, as that term is defined in PL 107-314, because activities constitute realistic testing of military equipment, vehicles, and sensors for proper operation and suitability for combat use. For military readiness activities, the relevant definition of harassment under the MMPA is any act that:

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

1. Injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment"); or
2. Disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered ("Level B harassment") (16 U.S.C. § 1362(18)(B)(i) and (ii)).

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 2016a). For purposes of this consultation, any exposure to Level A or Level B disturbance sound thresholds under the MMPA constitutes an incidental "take" under the ESA and must be authorized by the ITS (although take is not prohibited for threatened species such as Arctic ringed seals that do not have ESA section 4(d) regulations).

As described below, we anticipate that exposures to ringed seals from noise associated with the proposed action may result in behavioral disturbance. However, no mortalities or permanent impairment to hearing are anticipated.

6.2. Exposure Analysis

As discussed in the *Approach to the Assessment* section of this opinion, exposure analyses are designed to identify the listed species that are likely to co-occur with these effects in space and time and the nature of that co-occurrence. In this step of our analysis, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent. For critical habitat, exposure analyses identify any designated critical habitat likely to co-occur with effects and the nature of that co-occurrence. In this step of our analysis, we try to identify the physical and biological features likely to be exposed to an action's effects. As discussed in Section 2.1.2 above, the Navy proposed mitigation measures that should avoid or minimize exposure of ringed seals to one or more stressors from the proposed action. The Arctic ringed seal is the only listed marine mammal that may be exposed to the project activities. The discussion below describes the model the Navy uses to determine how many ringed seals may be exposed to their proposed activities. The Permits Division and AKR have also adopted this approach in support of their proposed IHA and biological opinion, respectively.

The Navy performed a quantitative analysis to estimate the number of mammals that could be harassed by the underwater acoustic transmissions during the proposed action (Navy 2021a). Inputs to the quantitative analysis included marine mammal density estimates obtained from the Navy Marine Species Density Database, marine mammal depth occurrence distributions, oceanographic and environmental data, marine mammal hearing data, and criteria and thresholds for levels of potential effects. The quantitative analysis consists of computer modeled estimates and a post-model analysis to determine the number of potential animal exposures. The model calculates sound energy propagation from the proposed sonars, the sound received by an animat (virtual animal) dosimeters representing marine mammals distributed in the area around the modeled activity, and whether the sound received by a marine mammal exceeds the thresholds for effects.

The Navy developed a set of software tools and compiled data for estimating acoustic effects on marine mammals without consideration of behavioral avoidance or mitigation measures. These databases and tools collectively form the Navy Acoustic Effects Model (NAEMO). In NAEMO, animats are distributed randomly based on species-specific density, depth distribution, and group size information, and animats record energy received at their location in the water column. A fully three-dimensional environment is used for calculating sound propagation and animat exposure in NAEMO. Site-specific bathymetry, sound speed profiles, wind speed, and bottom properties are incorporated into the propagation modeling process. NAEMO calculates the likely propagation for various levels of energy (sound or pressure) resulting from each source used during the training and testing event.

NAEMO then records the energy received by each animat within the energy footprint of the event and calculates the number of animats having received levels of energy exposures that fall within defined impact thresholds. Predicted effects on the animats within a scenario are then tallied and the highest order effect (based on severity of criteria; e.g., PTS over TTS) predicted for a given animat is assumed. Each scenario or each 24-hour period for scenarios lasting greater than 24 hours is independent of all others, and therefore, the same individual marine animal could be impacted during each independent scenario or 24-hour period. NAEMO provides the initial estimated impacts on marine species with a static horizontal distribution.

There are limitations to the data used in the acoustic effects model, and the results must be interpreted within this context. While the most accurate data and input assumptions have been used in the modeling, when there is a lack of definitive data to support an aspect of the modeling, modeling assumptions believed to overestimate the number of exposures have been chosen:

1. Animats are modeled as being underwater, stationary, and facing the source and therefore always predicted to receive the maximum sound level (i.e., no pinnipeds' heads above water).
2. Animats do not move horizontally (but change their position vertically within the water column), which may overestimate physiological effects such as hearing loss, especially for slow moving or stationary sound sources in the model.
3. Animats are stationary horizontally and therefore do not avoid the sound source, unlike in the wild where animals would most often avoid exposures at higher sound levels, especially those exposures that may result in PTS.
4. Multiple exposures within any 24-hour period are considered one continuous exposure for the purposes of calculating the temporary or permanent hearing loss, because there are not sufficient data to estimate a hearing recovery function for the time between exposures.
5. Mitigation measures that are implemented were not considered in the model. In reality, sound-producing activities would be delayed or stopped if marine mammals are detected within the mitigation zones around sound sources.

Because of these inherent model limitations and simplifications, model-estimated results must be further analyzed, considering such factors as the range to specific effects, avoidance, and the likelihood of successfully implementing mitigation measures. This analysis uses a number of factors in addition to the acoustic model results to predict acoustic effects on marine mammals.

When sound sources are active, exposure to increased sound pressure levels would likely involve individuals that are moving through the area during foraging trips. Ringed seals may also be exposed en route to subnivean lairs. If exposure were to occur, the seals could exhibit behavioral responses such as avoidance, increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, individuals affected by acoustic transmissions resulting from the proposed action would move away from the sound source and be temporarily displaced from their subnivean lairs (ringed seals) within the ice camp proposed action area. Any pinnipeds would have to be within 10 km or less from the source for any behavioral reaction (e.g., flushing from a lair). NMFS and the Navy conservatively set a distance cutoff of 10 km and this is due to the fact that empirical evidence has not shown responses to acoustic transmissions that would constitute a take beyond a few km from an acoustic source. Regardless of source level at that distance, take or behavioral response is not estimated to occur beyond 10 km of the source. Any effects experienced by individual seals are anticipated to be limited to short-term disturbance of normal behavior, temporary displacement, or disruption of animals near the proposed action.

Table 9 shows the exposures expected for the seals based on NAEMO modeled results looking at the acoustic sources specifically planned for use during the ICEX2022. Results from the quantitative analysis should be regarded as conservative estimates that are strongly influenced by limited marine mammal population data. While the numbers generated from the quantitative analysis provide conservative estimates of marine mammal exposures, the short duration of the exercise, the limited geographic extent of the ICEX event, and the implementation of mitigation measures would further limit actual exposures.

Table 9. Quantitative Modeling Results of Potential Exposures for 2022 ICEX Activities

Species	PTS (sound exposure level of at least 201 dB re 1 $\mu Pa^2 \cdot s$)	TTS (sound exposure level of 181-200 dB re 1 $\mu Pa^2 \cdot s$)	Behavioral
Ringed Seal	0	910	3,976

These quantitative calculations were then analyzed qualitatively, taking into account the best available data on the species itself, and how the species has been observed to respond to similar types of influences.

6.3. Response Analysis

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

6.3.1. Threshold Shifts

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

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

Based on the modeling done by the Navy and in agreement with the Permits Division, we do not expect ringed seals to be exposed to sound levels that would cause PTS because based on the NAEMO model no ringed seals are expected to be exposed to sound levels greater than 201 dB re 1 $\mu Pa^2 \cdot s$. If exposure to acoustic sources from 181-200 dB re 1 $\mu Pa^2 \cdot s$ occurs, ringed seals could experience TTS and could also exhibit behavioral responses which are discussed in more detail below.

6.3.2. Auditory Interference (masking)

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

Critical ratios, a measure of the relative ability of an animal to extract signals from noise, have been determined for pinnipeds (Southall et al. 2000, 2003) and bottlenose dolphins (Johnson 1967). These studies provide baseline information from which the probability of masking can be estimated.

Clark et al. (2009) developed a methodology for estimating masking effects on communication signals for low frequency cetaceans, including calculating the cumulative impact of multiple noise sources. They found that two commercial vessels passing through a North Atlantic right whale's optimal communication space decreased the size of that space by 84 percent. Subsequent research for the same species and location estimated that an average of 63 to 67 percent of North Atlantic right whale's communication space has been reduced by an increase in background noise levels, and that noise associated with transiting vessels is a major contributor to the increase in background noise (Hatch et al. 2012).

Vocal changes in response to anthropogenic noise can occur across sounds produced by marine mammals, such as whistling, echolocation click production, calling, and singing. Changes to vocal behavior and call structure may result from a need to compensate for an increase in background noise. In cetaceans, vocalization changes have been reported from exposure to anthropogenic noise sources such as sonar, vessel noise, and seismic surveying. Vocalizations may also change in response to variation in the natural acoustic environment (e.g., from variation in sea surface motion) (Dunlop et al. 2014).

Ringed seals have good low-frequency hearing; thus, it is expected that they will be more susceptible to masking of biologically significant signals by low frequency sounds, such as those from vessel noise (Gordon et al. 2003). However, as explained in Section 6.1.1.5, vessel noise from this project is expected to have a very temporary and minor effect on ringed seals.

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

Although ringed seals vocalize, there is no evidence that they use sound to find prey (echolocate) or evade predators. Ringed seals are prey for polar bears and killer whales. Because ringed seals are excellent swimmers, they are susceptible to attack by polar bears when basking on ice or exiting the water at a breathing hole, and not when they are in the water. Because ringed seals do not rely on sound in water to evade polar bears, auditory masking of a swimming polar bear is not a potential effect of this project. Killer whales are not present in the deep waters of the Beaufort Sea in the winter and therefore are not a threat at this time of year. Ringed seal calls are primarily barks, yelps, and growls (Jones et al. 2014). In looking at 928 recordings from the Chukchi Sea and 1,982 recordings from the Canadian High Arctic, (Jones et al. 2014) found that ringed seals mostly produce calls of very short duration (less than 0.3 seconds). The mean frequency of all calls was less than 1 kHz. Unlike many other phocids, ringed seal vocalizations cannot be heard by a human on the ice. Stirling and Thomas (2003) suggest that the exceptionally low signal strength of ringed seal vocalizations may have evolved in part to avoid detection by polar bears.

The extent to which ringed seals depend on vocalizations for mating and breeding is unclear; three years of recordings over the winter did not provide strong evidence that vocalizations were being used in mating (Jones et al. 2014). The characteristics of ringed seal vocalizations coupled with short term use of submarine transmissions indicates the probability that masking will occur is very low.

6.3.3. Behavioral Response

NMFS expects that ringed seals may have a behavioral response to the sounds created by the research devices. Marine mammals may exhibit a variety of behavioral changes in response to underwater sound and the general presence of project activities and equipment, which can be generally summarized as:

- Modifying or stopping vocalizations
- Changing from one behavioral state to another
- Movement out of feeding, breeding, or migratory areas

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

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

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

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

In cases where the seal response is brief (i.e., changing from one behavior to another, relocating a short distance, or ceasing vocalization), effects could rise to the level of take of individuals but are not likely to be significant at the population level. When individuals change their behavior, such as foraging, in response to underwater sound it has the potential to effect the animal's energy budget, time budget, or both (the two are related because foraging requires time). Here again, although the effects could rise to the level of take of a few individuals a population level effect would not be expected.

Marine mammal responses to anthropogenic sound vary by species, state of maturity, prior exposure, current activity, reproductive state, time of day, and other factors (Ellison et al. 2012). Southall et al. (2007) reported that pinnipeds do not exhibit strong reactions to SPLs up to 140 dB_{rms} re 1 µPa from non-impulsive sources. Data on hooded seals (*Cystophora cristata*) indicate avoidance responses to signals above 160–170 dB_{rms} re 1 µPa (Kvadsheim et al. 2010), and data on gray (*Halichoerus grypus*) and harbor seals indicate avoidance response at received levels of 135–144 dB_{rms} re 1 µPa (Götz et al. 2010). In each instance where food was available, which provided the seals motivation to remain near the source, habituation to the signals occurred rapidly. In the same study, it was noted that habituation was not apparent in wild seals where no food source was available (Götz et al. 2010). This implies that the motivation of the animal is necessary to consider in determining the potential for a reaction.

In one study aimed to investigate the under-ice movements and sensory cues associated with under-ice navigation of ice seals, acoustic transmitters (60–69 kHz at 159 dB_{rms} re 1 µPa at 1 m) were attached to ringed seals (Wartzok et al. 1992). An acoustic tracking system then was installed in the ice to receive the non-impulsive acoustic signals and provide real-time tracking of ice seal movements. Although the frequencies used in the study are at the upper limit of ringed seal hearing, the ringed seals appeared unaffected by the non-impulsive acoustic sources, as they maintained normal behaviors.

In studies by Götz et al. (2010), and Kvadsheim et al. (2010), seals that were exposed to non-impulsive acoustic sources with a received sound pressure level between 142–193 dB_{rms} re 1 µPa, were shown to change their behavior by modifying diving activity and avoidance of the sound source (Götz et al. 2010, Kvadsheim et al. 2010). Although a minor change to a behavior may occur as a result of exposure to the sources in the proposed action, these changes would be within the normal range of behaviors for the animal (e.g., the use of a breathing hole further from the source, rather than one closer to the source, would be within the normal range of behavior) (Kelly et al. 1988).

These studies indicate that depending on a variety of factors including availability of food, past experiences with anthropogenic sound, and distance from the source, ringed seals may avoid the sounds created by the submarines used in this project or they may have very little reaction to them.

6.3.4. Non-Auditory Physical or Physiological Effects

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

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

If a sound is detected by a marine mammal, a stress response (e.g., startle or annoyance) or a cueing response (based on a past stressful experience) can occur. Although preliminary because of the small numbers of samples collected, different types of sounds have been shown to produce variable stress responses in marine mammals. Whales and seals use hearing as a primary way to gather information about their environment and for communication; therefore, we assume that limiting these abilities is stressful. Stress responses may also occur at levels lower than those required for TTS (NMFS 2006). Therefore, exposure to levels sufficient to trigger onset of PTS or TTS are expected to be accompanied by physiological stress responses (NRC 2003, NMFS 2006).

We expect that the proposed action may result in ringed seals temporarily exhibiting behavioral responses or experiencing TTS from project activities. Therefore, we expect ringed seals may experience stress responses. If ringed seals are not displaced and remain in a stressful environment (i.e., within the behavioral harassment zone), we expect the stress response will dissipate shortly after the individual leaves the area or after the cessation of the acoustic stressor because the stressor will no longer be present, thus a biological response is no longer needed.

7. Cumulative Effects

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

We searched for information on non-Federal actions reasonably certain to occur in the action area. We did not find any information about non-Federal actions other than what has already been described in the Environmental Baseline (Section 5 of this Opinion). We expect all of those activities discussed in that section to continue into the future. We expect subsistence harvest of ringed seal to continue. We also expect that with commercial and private vessels operating in the Bering, Chukchi, and Beaufort Seas, the risk of non-permitted oil and pollutant discharges will continue and may increase. Because there is no federal nexus requiring section 7 consultation for the majority of vessels that will be transiting the Arctic this topic is discussed in more detail. In addition, another emerging issue which has the potential to effect Arctic marine food webs and for which there is no federal nexus is microplastics.

7.1. Vessel Traffic

The general seasonal pattern of vessel traffic in the Arctic is correlated with seasonal ice conditions, which result 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 Northern Sea Route reduces the distance between Northwest Europe and Northeast Asia by 40% compared to the passage through the Suez Canal. The Northwest Passage reduces the sailing distance between Northeast Asia and the U.S. Atlantic coast by 23% compared to the route via the Panama Canal (Bekkers et al. 2016). The two Arctic routes allow shipping companies to avoid increased tolls in the Suez and Panama Canals and provide routes for super ships that are larger and able to carry greater volumes of cargo (Nong et al. 2018).

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

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

In the first week of January 2021, a 908-foot Russian tanker carrying liquified natural gas passed south through the Russian side of the Bering Strait, and two more followed the next week. The ships traversed the northern coast of Siberia, on the North Sea Route, in the middle of January with no icebreaker escort, an unprecedented event. The Nikolay Zubov, built in 2019, is one of a fleet of 15 Russian ships that are specially designed to transport LNG through thin sea ice. In May of 2020, the first vessels of the season set a record for the earliest passage of the route by commercial tankers[14]. The passage of these ships is a stark reminder of how much the Arctic is changing and how vessel traffic will inevitably increase.

A report released by the Center for High North Logistics at Norway's Nord University Business School cited 62 transits through the Northern Sea Route between January 1 and December 9, 2020, compared to just 37 in all of 2019. An estimated 32 million tons of cargo passed along the route in 2020, compared to just 10.7 million tons in 2017. Russian president Vladimir Putin has stated that he aims to boost that number to 80 million by 2025. In 2019, the Russian government released a plan to have at least 40 Arctic vessels by 2035, many of them nuclear-powered icebreakers to keep the route passable by regular cargo ships for most of the year[17].

Increased use of icebreakers is also anticipated by the United States. The Coast Guard already has one heavy duty ice breaker under construction and hopes to procure three more heavy duty and three medium vessels in the coming years. Russia and China are also increasing their icebreaking fleets[15].

Impacts of greater vessel operations may include increased air-borne emissions levels (CO_2 and black carbon) increased underwater noise, potential for oil spills, introduction of nonnative species, and probability of ship strike.

7.2. Microplastics

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

[14] http://www.nomenugget.net/news/russian-tanker-passes-through-bering-strait-midst-winter
[15] https://www.nationaldefensemagazine.org/articles/2020/5/21/new-coast-guard-icebreaker-remains-on-tight-schedule

microplastics found in the Arctic included polystyrene, acrylic, polyethylene, polypropylene, nylon, polyester, and rayon (Obbard et al. 2014, Peeken et al. 2018). Microplastics are also abundant in Arctic benthic substrates (Lusher et al. 2015, Bergmann et al. 2017) and water (La Daana et al. 2018, La Daana et al. 2020).

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

Some continuing non-Federal activities are reasonably certain to contribute to climate change within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the climate change and environmental baseline (Sections 4.2 and 5.1, respectively).

There are currently no other known state or private activities reasonably certain to occur in the action area that may affect listed species and are not subject to section 7 consultation.

8. Integration and Synthesis

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

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

As part of our risk analyses, we considered all the consequences of exposing individual ringed seals to all of the potential 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. As mentioned earlier, critical habitat has been proposed for ringed seal (86 FR 1452) but it is not expected to be finalized before this project has concluded.

As discussed in Section 4.1, we concluded that the proposed activities may affect but will not adversely affect bearded seals. We came to this conclusion because it is extremely unlikely that they will be present in the area where project activities occur. The life history and migratory patterns of the species make it extremely unlikely that they will be present in the deep waters of the Beaufort Sea in the winter when project activities will occur. Because bearded seals will not be near the ice camp location, they may be exposed only to aircraft noise from the overflights after takeoff or before landing from the Deadhorse Airport. We expect that any bearded seals along the coast that are in the flight path from Deadhorse Airport to the ice camp are habituated to the sight and sound of aircraft and their reactions, if they occur at all, would not be measurable. The proposed project will increase the number of flights from the airport by approximately 10 percent with the most flights occurring during camp construction and demobilization. The mitigation measures regarding flight altitude and distance from seals will further reduce the potential for there to be adverse effects of the aircraft on bearded seals. Taking all of these factors into account, we expect that a few individuals may be exposed to overflight noise but the exposure would be brief and transitory, it would be noise they are accustomed to, and it is extremely unlikely to disrupt normal behavioral patterns. For these reasons we conclude that the proposed project is not likely to adversely affect bearded seals.

8.1. Ringed Seal Risk Analysis

Two overarching factors taken into consideration for our risk analysis are: 1) that the primary threat to ringed seals is climate change and loss of suitable habitat as a consequence of climate change; and 2) very few of the approximately 300,000 Arctic ringed seals (which is likely an underestimate of their true population size) are expected to be within the action area. These two factors help put the analysis of potential effects in perspective. Moreover, ICEX 2022 activities and their associated effects are very short term. Because of the density used in the NAEMO model, the estimate of take is conservative. Although the Navy used the best available information for ringed seal density, no surveys have been done in the Beaufort Sea in the vicinity of the ice camp in the winter. The actual density of ringed seals is probably far less than what they used for the following reasons:

1. Although ringed seals may be present in the action area, Frost et al. (2004) found that their density was highest at water depths between 25-35 m (82-115 ft). Although their

surveys extended only a short distance beyond the continental shelf, ringed seal density was significantly less at depths greater than 35-45 m (82-150 ft) (Frost et al. 2004). Frost et al. (2002) found the same significant relation, with seal density decreasing with depth up to 55 m (180 ft) (the maximum surveyed). Crawford et al. (2012) caught and tagged 25 seals from Kotzebue Sound in 2007 and 2008 and tracked their movements. Average water depth in which they stayed over time was 36.5 m (120 ft). Likewise, Bengtson et al. (2005) found ringed seals were four to ten times more abundant in nearshore fast and pack ice environments than in offshore pack ice, consistent with the pattern reported by other authors such as Smith (1973), who reported that densities of ringed seals were much lower beyond 29 km (18 mi) from shore. Bengtson et al. (2005) concluded that the higher density of ringed seals in the coastal areas was not surprising, given the importance of shore fast ice for ringed seal lairs and breeding habitat. These results lead us to believe that far fewer ringed seals will be present at the ICEX 2022 activity area because it will be well off the continental shelf in water 800 m (2,625 ft) or more in depth.

2. Early winter, prior to the occupation of breeding sites, is an important time in which female ringed seals accumulate enough fat stores to support estrus and lactation (McLaren 1958, Kelly et al. 2010b). We expect that ringed seals select habitats at this time where food is abundant and easily accessible to minimize the energy required to forage. Arctic cod, an important part of ringed seal diet, is abundant near shore from November to April when the fish concentrate to spawn (Logerwell et al. 2015). Foraging over the continental shelf where productivity is high and food more accessible (both fish and invertebrates available, and at shallower depths) is likely, in part, responsible for the distribution of seals that has been documented (Frost et al. 2002, Frost et al. 2004).
3. Because ringed seals have a diet that includes both benthic invertebrates and fish, at 800 m benthic invertebrates would be eliminated as a food option and ringed seals would have to depend exclusively on fish. We have no information on fish densities in the deep waters of the Arctic Ocean in the winter but reducing the food options would likely make the area less favorable for ringed seals.

In addition, as discussed in section 6.2, because of the assumptions made, the NAEMO model likely overestimates the number of ringed seals that might be exposed to the active sound sources. Finally, during monitoring for the 2018 ICEX in the same general area, the Navy did not visually observe or acoustically detect any marine mammals. During monitoring for ICEX 2020, the Navy did not visually observe any marine mammals or detect any discernible marine mammal vocalizations (Henderson et al. 2021). Consequently, the exposures we discuss below are most likely affecting very few ringed seals.

Based on NAEMO modeled results, NMFS estimates 910 takes of ringed seals by TTS from the submarine activities. TTS is a temporary impairment of hearing and can last from minutes or hours to days (in cases of strong TTS). In many cases, however, hearing sensitivity recovers rapidly after exposure to the sound ends. This activity has the potential to result in only minor levels of TTS, and hearing sensitivity of affected animals would be expected to recover quickly. Though TTS may occur in up to 910 ringed seals, the overall fitness of these individuals is unlikely to be affected given the temporary nature of TTS, and negative impacts to the population are not anticipated. NMFS estimates 0 takes of ringed seals by PTS.

Based on NAEMO modeled results, NMFS estimates 3,976 takes of ringed seals by behavioral harassment. Effects on individuals that are taken by Level B harassment by behavioral disturbance could include alteration of dive behavior, alteration of foraging behavior, effects to breathing, interference with or alteration of vocalization, avoidance, flight, as well as stress. More severe behavioral responses are not anticipated due to the localized, intermittent use of active acoustic sources and listening for vocalizing marine mammals before initiating active acoustic sources, which will limit exposure to active acoustic sources. Most likely, individuals will be temporarily displaced by moving away from the sound source. Although a minor change to a behavior may occur as a result of exposure to the sound sources associated with the proposed specified activity, these changes would be within the normal range of behaviors for the animal (e.g., the use of a breathing hole further from the source, rather than one closer to the source). Thus, even repeated Level B harassment of some small subset of the overall population is unlikely to result in any significant realized decrease in fitness for the affected individuals, and would not result in any adverse impact to the Arctic subspecies as a whole.

Exposure to aircraft noise, noise from snow machines ad on-ice vehicles, noise from ice augering, authorized discharge, and small oil or lubricant spills may occur but would not rise to the level of take. Because of the Standard Operating Procedures and mitigation measures which are proposed as part of this action, stressors associated with on-ice activities (camp construction and decommissioning, camp operation, excursions) and human presence are expected to affect individual ringed seals very infrequently, if at all. Finally, exposure to vessel strike, entanglement, and marine debris is extremely unlikely to occur.

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). Early winter period, prior to the occupation of breeding sites, is important in allowing female ringed seals to accumulate enough fat stores to support estrus and lactation (Kelly et al. 2010b). This early winter period overlaps camp construction and the first weeks of the exercises. However, the individual and cumulative energy costs of the behavioral responses we have discussed are not likely to reduce the energy budgets of ringed seals. As a result, the ringed seal's probable responses (i.e., tolerance, avoidance, short-term masking, and short-term vigilance behavior) are not likely to reduce the fitness or current or expected future reproductive success or reduce the rates at which they grow, mature, or become reproductively active. Therefore, these exposures are not likely to reduce the abundance, reproduction rates, and growth rates (or increase variance in one or more of these rates) of the population those individuals represent. For physical disturbance, the ice camp will be sited to reduce potential disruption of ringed seal lairs. In addition, the mitigation measures further reduce the likelihood of a lair or a seal being affected by snow machine use. If an individual ringed seal were disturbed and flushed into the water this impact is not likely to reduce its reproductive rate, growth rate, or the growth rate of the population.

Exposure to vessel noise, aircraft noise (fixed-wing aircraft, helicopters, and UAS), noise from habitat alteration (ice auguring), and small oil spill discharge may occur as part of the proposed action, but are considered insignificant and would not rise to the level of take. The occurrence of vessel strikes are considered extremely unlikely due to the agility of seals in the water, their low density, implementation of mitigation measures, and low number of vessels associated with the action. Exposure to harmful pollution and marine debris is extremely unlikely.

As we discussed in the *Approach to the Assessment* section of this opinion, an action that is not likely to reduce the fitness of individual seals would not be likely to reduce the viability of the populations those individual seals represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of such populations). For the same reasons, an action that is not likely to reduce the viability of those populations is not likely to increase the extinction probability of the species those populations comprise; in this case, the ringed seal. As a result, the effects associated with the proposed Arctic military exercises are not likely to appreciably reduce the ringed seals' likelihood of surviving or recovering in the wild, when considered along with the environmental baseline and cumulative effects.

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 ringed seal. Critical habitat has not been designated, 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 results from, but is not the purpose of, the carrying out of an otherwise lawful activity conducted by the action agency or applicant (50 CFR § 402.02). Based on NMFS guidance, the term "harass" under the ESA means to: "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (Wieting 2016b).

The National Defense Authorization Act of Fiscal Year 2004 (PL 108-136) amended the definition of "harassment" under the MMPA, specifically as it applies to military readiness activities or scientific research activities conducted by or on behalf of the federal government (16 U.S.C. §1362 (18)(B)). The Fiscal Year 2004 National Defense Authorization Act adopted the definition of "military readiness activity" as set forth in the Fiscal Year 2003 National Defense Authorization Act (PL 107-314). Research activities within the study area are composed of military readiness activities, as that term is defined in PL 107-314, because activities constitute realistic testing of military equipment, vehicles, and sensors for proper operation and suitability for combat use. For military readiness activities, the relevant definition of harassment under the MMPA is any act that:

- Injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment"); or
- Disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered ("Level B harassment") (16 U.S.C. § 1362(18)(B)(i) and (ii)).

For this consultation, the Permits Division anticipates that any take will be by harassment only. No Level A takes are contemplated or authorized.

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, and therefore ESA section 9 take prohibitions do not apply to this species. This ITS includes numeric limits on the take of this 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 this threatened species.

Section 7(b)(4)(C) of the ESA provides that if an endangered or threatened marine mammal is involved, the taking must first be authorized under section 101(a)(5) of the MMPA. Accordingly, the reasonable and prudent measures and terms and conditions of this Incidental Take Statement become effective only upon the issuance of MMPA authorization to take the marine mammals identified here. Absent such authorization, this Incidental Take Statement is inoperative.

The Terms and Conditions described below are nondiscretionary. The Navy and the Permits Division have a continuing duty to regulate the activities covered by this ITS. In order to monitor the impact of incidental take, the Navy and the Permits Division must monitor the progress of the action and its impact on the species as specified in the ITS (50 CFR 402.14(i)(3)).

10.1. Amount or Extent of Take

The section 7 regulations require NMFS to estimate the number of individuals that may be taken by proposed actions or use 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); see also 80 FR 26832 (May 11, 2015)).

NMFS anticipates the proposed ICEX2022 project in the Beaufort Sea, Alaska, from February to April, 2022 is likely to result in the incidental take of ringed seals by harassment, including TTS and behavioral harassment. The Permits Division estimated take by considering: 1) acoustic thresholds above which the best available science indicates marine mammals will be behaviorally harassed or incur some degree of temporary hearing impairment; 2) the range to which behavioral effects were anticipated to reach; and 3) the density or occurrence of marine mammals within these ensonified areas. AKR and the Permits Division relied heavily on the NAEMO model developed by the Navy for assessing the impacts of underwater sound (Navy 2021a, b)

Underwater acoustic transmissions associated with ICEX22 have the potential to result in Level B harassment of ringed seals in the form of TTS (910) and behavioral disturbance (3,976). No take by Level A harassment, serious injury, or mortality is anticipated to result from this activity and none is authorized. Further, at close ranges and high sound levels approaching those that could cause PTS, seals would likely avoid the area immediately around the sound source. Through our analysis we conclude that the take will be far less than the permitted amount (section 8.1); however, because we do not have information about the sonar transmission levels nor do we have reliable density estimates for the action area, we do not have the information necessary to arrive at a lower take estimate. Therefore, this opinion considers the full amount of take authorization requested by the Navy and proposed by the Permits Division.

Any incidental take of ringed seals considered in this consultation is restricted to the permitted action as proposed. If the actual incidental take exceeds the estimated level or type of take, the Navy and the Permits Division may be required to reinitiate consultation. Likewise, if the action deviates from what is described in Section 2.1.2 Standard Operating Procedures and Mitigation Measures of this biological opinion, the Navy and the Permits Division may be required to reinitiate consultation. All anticipated takes will be by harassment, as described previously, involving temporary changes in behavior.

10.2. Effect of the Take

In section 9 of this Opinion, NMFS determined that the level of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the Arctic ringed seal.

NAEMO modelling indicated that ringed seals would have to be within 10 km from the source to elicit any behavioral reaction (e.g., flushing from a lair) (86 FR 70451). If exposure were to occur, ringed seals may exhibit behavioral responses such as avoidance, increased swimming speeds, decreased foraging time or increased on-ice resting time.

The takes from the proposed action are associated with behavioral harassment from acoustic effects. Although the biological significance of behavioral responses remains unknown, this consultation has assumed that exposure to noise sources might disrupt one or more behavioral patterns that are essential to an individual animal's life history. However, any behavioral responses of the ringed seals to noise sources and any associated disruptions are not expected to affect the fitness of any individuals of these species, the viability of the population, or the species' survival or recovery.

10.3. Reasonable and Prudent Measures

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

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

The RPM included below, along with their implementing terms and conditions, is 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 Arctic ringed seals resulting from the proposed action.

RPM 1: The Navy and the Permits Division will monitor for take and the effects of their action on listed marine mammals, and should document and report relevant aspects of its research and testing activities to verify implementation of the mitigation measures and compliance with permits, and to improve future environmental assessments.

10.4. Terms and Conditions

"Terms and conditions" implement the reasonable and prudent measures (50 CFR § 402.14). These terms and conditions are in addition to the mitigation measures included in the proposed action, as set forth in Section 2.1.2 of this opinion. The Navy and the Permits Division have a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR § 402.14(i)(3)).

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

To carry out the RPM 1 listed in Section 10.3, the following must occur:

1. The Navy and the Permits Division must provide NMFS AKR with written and photographic (if applicable) documentation of any observed effects of the proposed actions on listed marine mammals and implementation of the mitigation measures specified in section 2.1.2 of this Biological Opinion.

11. Conservation Recommendations

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

In order to keep NMFS's Protected Resources Division informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Navy should notify NMFS of any conservation recommendations they implement in their final action.

1. The Navy should review all new and relevant marine mammal population and density data from the Arctic and incorporate that information as inputs into NAEMO.
2. The Navy should deploy passive acoustic monitors in the Beaufort Sea to provide a better understanding of marine mammal presence in the area during the ICEX timeframe.
3. The Navy should explore the use of eDNA to determine the presence of ringed seals in the action area during the ICEX timeframe.

12. Reinitiation of Consultation

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

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

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

13.2. Integrity

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

13.3. Objectivity

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

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

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

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

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