Environmental Assessment/
Overseas Environmental Assessment
For the
Ice Exercise Program

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Lead Agency
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Action Proponent
Commander, U.S. Fleet Forces Command

ENVIRONMENTAL ASSESSMENT/OVERSEAS ENVIRONMENTAL ASSESSMENT

FOR THE ICE EXERCISE PROGRAM

Lead Agency: Department of the Navy

Cooperating Agency: None

Title of the Proposed Action: The Ice Exercise Program

Designation: Final

ABSTRACT

The United States Department of the Navy prepared this Environmental Assessment (EA)/Overseas Environmental Assessment (OEA) in compliance with the National Environmental Policy Act (NEPA) and Executive Order (EO) 12114, Department of Defense regulations found at 32 Code of Federal Regulations Part 187, and the Chief of Naval Operations Instruction 5090.1 and its accompanying manual (M-5090).

This EA/OEA evaluates the potential impact to the environment from the Ice Exercise (ICEX) Program. The need for the Proposed Action is to prepare forces capable of extended operations and warfighting in the Arctic in accordance with Title 10 U.S.C. § 8062, and to support the aims of the Arctic Research and Policy Act (15 United States Code §§ 4101 *et seq.*). The purpose of the Navy's Proposed Action is to conduct realistic training and testing in an Arctic environment, and if resources are available, to gather data on environmental conditions and technology suitability in an Arctic environment. This EA/OEA evaluates the following alternatives: the No Action Alternative; Alternative 1 would conduct an ICEX (submarine testing and training with the inclusion of research activities and construction of a support camp) biennially but no construction of a Beta camp during years in which an ICEX is not conducted; and Alternative 2 an ICEX (submarine testing and training with the inclusion of research activities and construction of a support camp) would be conducted biennially, and a Beta camp would be constructed either on an ice floe or in Deadhorse, Alaska during years in which an ICEX is not conducted.

In this EA/OEA, the Navy analyzed potential impact to the environment that could result from the No Action Alternative and two Action Alternatives. The resources evaluated include marine habitats, marine invertebrates, marine birds, fish, Essential Fish Habitat, and mammals (marine and terrestrial).

Prepared by: United States Department of the Navy

Point of Contact: Ms. Laura Busch
Natural Resources Program Manager
1562 Mitscher Avenue, Suite 250
Norfolk, Virginia 23551-2487

Executive Summary

PROPOSED ACTION

The Navy's Proposed Action is to conduct submarine training and testing activities, which includes the establishment of a tracking range and temporary ice camp, and conduct research in an Arctic environment. The submarine and tracking range activities would be conducted biennially, but a temporary ice camp would be established annually, either in the ice camp study area (Figure 2-1) or on a frozen lake in Deadhorse, Alaska. The purpose of the Navy's Proposed Action is to evaluate the employment and tactics of submarine operability in Arctic conditions. The Navy's Proposed Action would also evaluate emerging technologies and assess capabilities in the Arctic environment, and gather data on Arctic environmental conditions. Some of the submarine training and testing may occur throughout the deep Arctic Ocean basin near the North Pole, within the Study Area (Figure 2-1). Beta camps would be constructed during years in which an ICEX is not conducted to support the expeditionary testing and evaluation of Arctic equipment, and would involve fewer personnel and be shorter in duration that camps constructed during years in which an ICEX is conducted. The Navy's proposed action is needed because the United States (U.S.) needs submarines to continue to train in the Arctic to refine and validate procedures and required equipment, as the Arctic Ocean serves as a route for submarines to transit between the Atlantic and Pacific Oceans. In addition to the primary objective of submarine training and testing, military and academic institutions collaterally benefit from the use of the ice camp to test new systems and conduct data collection and research in and about the Arctic environment. The purpose of this Environmental Assessment (EA)/Overseas Environmental Assessment (OEA) is to assess the environmental effects of the Ice Exercise (ICEX program) including the construction of a camp on an ice floe to support the submarine training and testing, and construction of beta camps.

The National Marine Fisheries Service's (NMFS) proposed action is to issue a one-year incidental harassment authorization (IHA) pursuant to the Marine Mammal Protection Act (MMPA) to authorize the non-intentional harassment of marine mammal species and stocks incidental to the Navy's testing and training activities, if all required findings and determinations can be made. The purpose of NMFS' proposed action is to evaluate the Navy's proposed action pursuant to the requirements of the MMPA and make a determination of whether an IHA should be issued and any mitigation, monitoring, and reporting measures that should be included. The need for NMFS' proposed action is to consider the impacts of the Navy's activities on marine mammals and meet NMFS' obligations under the MMPA.

ALTERNATIVES

For this EA/OEA, three alternatives were analyzed: the No Action Alternative and two Action Alternatives. Under the No Action Alternative, ICEXs would not be conducted biennially, Beta camps would not be constructed in the alternate years, and NMFS would not issue an IHA under the MMPA. Alternative 1 would conduct an ICEX (submarine testing and training with the inclusion of research activities) biennially with no Beta camp constructed during the alternate years, and under Alternative 2 an ICEX would be conducted biennially, with the Beta camp constructed on the alternate years (when there is no ICEX), either on an ice floe or in Deadhorse, Alaska. NMFS' Action Alternative is to issue a one-year IHA under the MMPA that would authorize the incidental, but not intentional, harassment of marine mammal species or stocks that is caused by the Navy's activities, provided that all required findings and determinations under the MMPA can be made.

ENVIRONMENTAL CONSEQUENCES

Potential environmental stressors include acoustic stressors (acoustic transmissions, aircraft noise, and on-ice vehicle noise), physical stressors (aircraft, on-ice, and in-water vessel/vehicle strike, and human presence), and stressors associated with expended material (bottom disturbance, combustive byproducts, entanglement, and ingestion). The potential environmental consequences of these stressors have been analyzed in this EA/OEA for resources associated with the natural, physical, and socioeconomic environments. Quantitative analysis was performed on those resources, namely marine mammals, for which numerical impact thresholds have been established. For those resources for which no thresholds have been established or appropriate information was not available, a qualitative approach was used.

Under section 7 of the Endangered Species Act (ESA), the Navy requested initiation of informal consultation with the U.S. Fish and Wildlife Service (USFWS) for the polar bear. USFWS concurred with the Navy's finding that the Proposed Action may affect, but is not likely to adversely affect, polar bears (*Ursus maritimus*), on February 2, 2022. A formal consultation, under section 7 of the ESA, was requested for the ringed seal and bearded seal with NMFS and NMFS provided a Biological Opinion on January 31, 2022. In accordance with the MMPA, an application for an IHA was prepared for the harassment of marine mammals (ringed seals and bearded seals) incidental to active acoustic transmissions, and submitted to NMFS on August 26, 2021. On December 10, 2021, NMFS published a notice in the Federal Register of a proposed IHA to authorize the harassment of marine mammals incidental to ICEX 2022 (86 FR 70451). NMFS solicited public comment on the proposed IHA through January 10, 2022. In addition, an intentional take permit (for the active deterrence of polar bears) under the MMPA was obtained from the USFWS on February 1, 2022.

The Navy completed Essential Fish Habitat consultation with NMFS for the previous ICEX (in 2016), in accordance with the Magnuson-Stevens Fishery Conservation and Management Act. Since NMFS determined that the Proposed Action would not likely effect Essential Fish Habitat and no conservation recommendations were provided, consultation was not reinitiated for the ICEX in 2018, 2020, or this ICEX. Finally, the Navy received a National Pollutant Discharge Elimination System permit from the Environmental Protection Agency for the discharge of graywater and reverse osmosis reject water from the ice camp into the Beaufort Sea.

The results of the analysis indicate that, with the implementation of standard operating procedures and mitigation measures, neither of the two Action Alternatives would significantly impact the natural and physical environments.

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Acronyms and Abbreviations

ºC	degrees Celsius
°F	degrees Fahrenheit
BOEM	Bureau of Ocean Energy Management
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cm	centimeter(s)
cm/s	centimeters per second
dB re 1 µPa	decibel(s) referenced to 1 micropascal
dB re 20 µPa	decibel(s) referenced to 20 micropascal
dBA	A-weighted sound levels
EA	Environmental Assessment
EMATT	Expendable Mobile Anti-Submarine Warfare Training Targets
EO	Executive Order
ESA	Endangered Species Act
GHG	Greenhouse gases
Hz	Hertz
ICEX	Ice Exercise
IHA	Incidental Harassment Authorization
km	kilometer(s)
km^2	kilometers squared
kHz	kilohertz
lb	pound(s)
m	meter(s)
Magnuson-Stevens Act	Magnuson Stevens Fishery Conservation and Management Act
mg/gallon	Milligram(s) per gallon
MMPA	Marine Mammal Protection Act
NAAQS	National Ambient Air Quality Standards
NAEMO	Navy Acoustic Effects Model
Navy	United States Department of the Navy
NEPA	National Environmental Policy Act
nm	nautical miles
NMFS	National Marine Fisheries Service
NMSDD	Navy Marine Species Density Database
OAML	Oceanographic and Atmospheric Master Library
OEA	Overseas Environmental Assessment
psu	practical salinity units
PTS	Permanent Threshold Shift
SAS	Synthetic aperture source
SEL	Sound Exposure Level
SPL	Sound Pressure Level
TTS	Temporary Threshold Shift
U.S.	United States
U.S.C.	United States Code
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service

CHAPTER 1 PURPOSE AND NEED

1.1 INTRODUCTION

The United States (U.S.) Department of the Navy (Navy) has maintained a presence in the Arctic region for decades. Navy experience spans Admiral Byrd's historic overflight of the North Pole in 1926, various campaigns in World War II, consistent activity during the Cold War, and combined exercises with surface, subsurface, aviation, and expeditionary forces today. While the Arctic is not unfamiliar for the Navy, expanded capabilities and capacity are needed for the Navy to increase its engagement in this region.

In 2012, Arctic sea ice reached its smallest yearly extent in recorded history, breaking the previous record set in 2007. This type of physical change in the Arctic is unprecedented in both the rate and scope of change. As a result, commercial shipping, resource development, research, tourism, environmental interests, and military focus in the region are projected to reach new levels of activity. Because of these changes, the Navy's strategic blueprint for the Arctic titled *A Blue Arctic* (a document that provides direction to the Navy to enhance the Navy's ability to operate in the Arctic region) describes "how the Department will apply naval power as we continue to prepare for a more navigable Arctic Region over the next two decades" (Chief of Naval Operations 2021).

An Ice Exercise (ICEX) event involves the construction of a camp on an ice floe to support submarine training and testing, which includes the establishment of a tracking range; and the conduct of research in an Arctic environment. Ice camps are an integral portion of the ICEX program and are also established to evaluate equipment, systems, and processes. The submarine and tracking range activities would be conducted biennially with torpedo exercises conducted every four years. A temporary ice camp would be established annually, either in the ice camp study area (Figure 2-1) or on a frozen lake in Deadhorse, Alaska (Figure 2-2). Ice camps established during the years without submarine activity are referred to as "Beta camps", and can be constructed either on an ice floe or on a frozen lake. Beta camps would be constructed to support the expeditionary testing and evaluation of Arctic equipment, and would involve less personnel and be shorter in duration. U.S. submarines must continue to train in the Arctic to refine and validate procedures and required equipment, as the Arctic Ocean serves as a route for submarines to transit between the Atlantic and Pacific Oceans. In addition to the primary objective of submarine training and testing, military and academic institutions collaterally benefit from the use of the ice camp to test new systems and conduct data collection and research in and about the Arctic environment.

The Navy prepared this Environmental Assessment (EA)/Overseas Environmental Assessment (OEA) to analyze the potential effects from a proposed ICEX on the environment in compliance with the National Environmental Policy Act (NEPA), Executive Order (EO) 12114, Department of Defense regulations found at 32 Code of Federal Regulations (CFR) Part 187, and the Chief of Naval Operations Instruction 5090.1D and its accompanying manual (M-5090.1). The EA/OEA will also be used in support of applications for one-year IHAs submitted by the Navy under the MMPA to NMFS. If issued, an IHA would allow the non-intentional, "take by harassment" of marine mammals incidental to the training and testing activities within the area of activities.

1.2 Purpose and Need

The purpose of the Navy's Proposed Action is to evaluate the employment and tactics of submarine operability in Arctic conditions. The Proposed Action would also evaluate emerging technologies and assess capabilities in the Arctic environment, and gather data on Arctic environmental conditions. The need for the Proposed Action is to prepare forces capable of extended operations and warfighting in the Arctic in accordance with Title 10 United States Code (U.S.C.) § 5062 and the Navy's strategic blueprint for the Arctic titled *A Blue Arctic*.

NMFS' purpose is to evaluate the Navy's Proposed Action pursuant to NMFS' authority under the MMPA, and to make a determination whether to issue an IHA, including any conditions or mitigation measures along with monitoring and reporting requirements needed to meet the statutory requirements of the MMPA. To authorize the incidental take of marine mammals, NMFS evaluates the best available scientific information to determine whether the anticipated incidental take would have a negligible impact on the affected marine mammal species or stocks and an unmitigable impact on their availability for taking for subsistence uses. NMFS must also prescribe permissible methods of taking, other "means of effecting the least practicable adverse impact" on the affected species or stocks and their habitat, and monitoring and reporting requirements. NMFS cannot issue an IHA unless it can make the required findings. The need for NMFS' proposed action is to consider the impacts of the Navy's activities on marine mammals and meet NMFS' obligations under the MMPA. This EA/OEA analyzes the environmental impacts associated with issuance of the requested authorization for the take of marine mammals incidental to the training and testing activities (i.e., active acoustic transmissions and their corresponding mitigation measures) within the area of the activities. The analysis of mitigation measures considers means of reducing impacts on marine mammal species or stocks and their habitat, and analyzes the practicability and efficacy of each measure. This analysis of mitigation measures will be used to support requirements pertaining to mitigation, monitoring, and reporting that would be specified in an IHA, if issued.

1.3 Applicable Laws and Directives

1.3.1 National Environmental Policy Act (NEPA)

NEPA (42 U.S.C. §§ 4321 *et seq.*) was enacted to provide for the consideration of environmental factors in federal agency planning and decision making. NEPA requires federal agencies to analyze the potential impacts of a Proposed Action on the human environment, which includes the physical, biological, and socioeconomic environments and the relationship of people with that environment. The Navy undertakes environmental planning for major Navy actions occurring throughout the world in accordance with applicable laws, regulations, and executive orders. Presidential Proclamation 5928, issued December 27, 1988, extended the exercise of U.S. sovereignty and jurisdiction under international law to 12 nautical miles (nm).

This EA/OEA was prepared pursuant to the requirements of NEPA and subsequent implementing regulations issued by the Council on Environmental Quality (2020) (40 CFR §§ 1500 *et seq.*). This document also is in conformance with the provisions of the Navy's Environmental Readiness Program Manual (OPNAVINST 5090.1 CH-1).

In addition, NMFS, in accordance with 40 CFR 1506.3, intends to adopt this EA/OEA and issue a separate Finding of No Significant Impact associated with its decision to grant or deny the Navy's request for an IHA pursuant to section 101(a)(5)(D) of the MMPA.

1.3.2 Executive Order 12114

EO 12114 (44 FR 1957), Environmental Effects Abroad of Major Federal Actions, directs federal agencies to be informed of and take account of environmental considerations when making decisions regarding major federal actions outside the United States, its territories, and possessions. The EO requires environmental consideration of actions with the potential to significantly harm the global commons, which are the geographic areas outside the jurisdiction of any nation, including the oceans beyond the territorial sea, which the United States defines as 12 nautical miles (nm). The purpose of EO 12114 is for agency decision makers to be informed of pertinent environmental considerations and to take environmental considerations into account, with other pertinent considerations of national policy, in making decisions.

In accordance with EO 12114 and the Department of Defense's implementing regulations in 32 CFR Part 187, this EA/OEA evaluates the potential for significant environmental harm from the Proposed Action in ocean waters beyond the territorial limits of the United States.

1.3.3 Arctic Research and Policy Act

The Arctic Research and Policy Act of 1984, as amended in 1990 (15 U.S.C. §§ 4101-4111), reaffirms that the Arctic is critical to national defense (15 U.S.C. §§ 4101). Conducting ICEXs is consistent with the goals of the Arctic Research and Policy Act, by helping to ensure the continued naval capability in the Arctic furthering national defense. Additionally, research activities conducted as a collateral benefit during submarine training and testing supports the Arctic Research and Policy Act goal for basic and applied scientific research in the Arctic. This act also established the U.S. Arctic Research Commission. The purpose of the commission is: (1) to establish the national policy, priorities, and goals for a basic and applied scientific research program, (2) to promote Arctic research, to recommend Arctic research policy, and to communicate policy recommendations to the President and Congress, (3) to work with the National Science Foundation to implement the Arctic research policy and to support cooperation and collaboration throughout the federal government, (4) to give guidance to the Interagency Arctic Research Policy Committee to develop Arctic research projects, and (5) to interact with Arctic residents, international Arctic research programs and organizations to assess Arctic research needs (United States Arctic Research Commission (USARC) 2010). The Arctic Research and Policy Act also established an Interagency Arctic Research Policy Committee, on which the Department of Defense is represented (15 U.S.C. § 4107(b)).

1.3.4 Clean Water Act

The Clean Water Act (33 U.S.C. §§ 1251-1376) is the cornerstone of surface water quality protection in the United States. Section 403 of the Clean Water Act (33 U.S.C. § 1343) and implementing EPA regulations (40 CFR Part 125 Subpart M) set forth criteria for assessing impacts from discharges of pollutants from point sources into ocean waters. No permit can be issued if the Environmental Protection Agency finds that the discharge would result in an unreasonable degradation of the marine environment (40 CFR § 125.123).

In accordance with Section 403, the Navy applied for and received a National Pollution Discharge Elimination System permit from the U.S. Environmental Protection Agency on September 10, 2021, effective January 1, 2022 for the discharge of graywater from the ice camp (Appendix A). This was a modification of the prior NPDES permit with an effective date of December 1, 2019.

1.3.5 Endangered Species Act

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and/or USFWS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS and/or USFWS provides an opinion stating how the agency's actions would affect listed species and their critical habitat. If incidental take of threatened or endangered species is reasonably certain to occur, section 7(b)(4) requires NMFS and/or USFWS to provide an Incidental Take Statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

The ESA defines the term “take” to mean “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt any such conduct” (16 U.S.C. §1532(19)). The regulatory definitions of “harm” and “harass” are relevant to the Navy’s determination as to whether the Proposed Action would result in adverse effects on listed species.

- Harm is defined by regulation as “an act which actually kills or injures” fish or wildlife (50 CFR § 222.102, 50 CFR § 17.3; 64 FR 60727, Nov 8 1999).
- Harass is defined by the U.S. Fish and Wildlife Service (USFWS) regulation to mean an “intentional or negligent act or omission which creates 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” (50 CFR § 17.3). The National Marine Fisheries Service (NMFS) has interim guidance regarding the definition of harassment (NMFSPD 02-110-19 December 21, 2016).

In accordance with the ESA, a formal consultation was initiated based on the determination that the Navy’s Proposed Action may affect, and is likely to adversely affect bearded seals (Erignathus barbatus nauticus) and ringed seals (Phoca hispida). NMFS provided a Biological

Opinion on January 31, 2022 (Appendix B). Informal consultation for the polar bear (*Ursus maritimus*) with USFWS was initiated based on the determination that the Navy's Proposed Action may affect, but is not likely to adversely affect polar bears. USFWS provided a Letter of Concurrence on February 2, 2022 (Appendix B).

1.3.6 Marine Mammal Protection Act

The MMPA (16 U.S.C. §§ 1361-1407) established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction. The act further regulates "takes" of marine mammals in U.S. waters and by U.S. citizens on the high seas. The term "take," as defined in Section 3 (16 U.S.C. § 1362) of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal."

The MMPA defines harassment as applied to military readiness activities. The Proposed Action constitutes a military readiness activity as defined in Public Law 107-314 (16 U.S.C. § 703) because these activities constitute "[t]raining operations of the Armed Forces that relate to combat, as well as adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat use." For military readiness activities, such as the Proposed Action, the relevant definition of harassment 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)).

Section 101(a)(5)(D) of the MMPA gives NMFS and/or USFWS the authority to authorize (through the issuance of an IHA) the incidental, but not intentional, take of small numbers of marine mammals by harassment, provided certain determinations are made and statutory and regulatory procedures are met. The "small numbers" requirement does not apply to military readiness activities. Serious injury and mortality cannot be authorized under this provision; activities that may result in serious injury or mortality of marine mammals must be authorized under section 101(a)(5)(A). In addition, an IHA may only be issued to cover incidental harassment for up to one year. To authorize the incidental take of marine mammals, NMFS and/or USFWS evaluates the best available scientific information to determine whether the take would have a negligible impact on marine mammal species or stocks, and whether the activity would have an unmitigable adverse impact on the availability of affected marine mammal species or stocks for subsistence use. NMFS and/or USFWS cannot issue an IHA if it would result in more than a negligible impact on marine mammal species or stocks or would result in an unmitigable adverse impact on the availability of marine mammals for subsistence uses. NMFS and/ or USFWS must also prescribe the permissible methods of taking and other means of effecting the least practicable impact on the species or stocks of marine mammals and their habitat, paying particular attention to rookeries, mating grounds, and other areas of similar significance. Where applicable, NMFS and/or USFWS must prescribe means of effecting the least practicable impact on the availability of the species or stocks of marine mammals for subsistence uses. IHAs include additional requirements or conditions pertaining to monitoring and reporting.

In addition to incidental taking of marine mammals, section 101(a)(4)(B) provides an exception to otherwise prohibited acts, allowing the use of measures that may deter a marine mammal from, among other things, damaging private property or endangering personal safety (16 U.S.C. 1371(a)(4)(A)(ii) and (iii), respectively. These measures may not result in the death or serious injury of a marine mammal. Section 101(a)(4)(A) of the MMPA specifically identifies the circumstances when the deterrence of a marine mammal may be undertaken and by whom. For polar bears, the USFWS has provided deterrence guidelines in 50 CFR § 18.34. These guidelines, if followed by a person otherwise subject to the provisions of the MMPA, provide an exception to the take prohibition under the MMPA; therefore, a permit under the MMPA is not required. Outside of the 50 CFR § 18.34 guidelines, use of deterrents against a polar bear requires an "intentional take permit" from the USFWS. Additionally, section 101(c) of the MMPA specifically states that, "it shall not be a violation of this chapter to take a marine mammal if such taking is imminently necessary in self-defense or to save the life of a person in immediate danger, and such taking is reported to the Secretary within 48 hours."

Based on the analysis contained herein, on August 26, 2021, the Navy applied for a one-year IHA from NMFS for the taking of ringed seals and bearded seals associated with an ICEX in 2022. On December 10, 2021, NMFS published a notice in the Federal Register of a proposed IHA to authorize the harassment of marine mammals incidental to the ICEX in 2022 (86 FR 70451) (Appendix C). NMFS solicited public comment on the proposed IHA through January 10, 2022. Additionally, a request for the intentional take (deterrence) of polar bears was requested for personnel and polar bear safety. A letter of authorization was received by USFWS on February 1, 2022 (Appendix C).

1.3.7 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) (16 U.S.C. §§ 1801-1822), enacted to conserve and restore the nation's fisheries, includes a requirement for NMFS and regional fishery councils to describe and identify Essential Fish Habitat for all species that are federally managed. Essential Fish Habitat is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. Under the Magnuson-Stevens Act, federal agencies must consult with the Secretary of Commerce regarding any activity or proposed activity that is authorized, funded, or undertaken by the agency that may adversely affect Essential Fish Habitat. An adverse effect is any effect that may reduce the quantity or quality of Essential Fish Habitat. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of Essential Fish Habitat.

In accordance with the Magnuson-Stevens Act, consultation with NMFS was initiated for the previous ICEX (in 2016) based on the determination of potential adverse effects to Essential Fish Habitat for the Arctic cod. NMFS previously determined that the Proposed Action would not likely reduce quantity or quality of Essential Fish Habitat, and therefore no conservation recommendations were provided. Since the effects to Essential Fish Habitat did not change from ICEX 2016 to 2021, consultation was not reinitiated.

1.3.8 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (16 U.S.C. §§ 703-712) was enacted to ensure the protection of shared migratory bird resources. The Migratory Bird Treaty Act prohibits the take, possession, import, export, transport, selling, purchase, barter, or offering for sale, purchase or barter, of any migratory bird, their eggs, parts, and nests, except as authorized under a valid permit. The Migratory Bird Treaty Act protects a total of 1,026 bird species; the list of species protected by the Migratory Bird Treaty Act appears in 50 CFR § 10.13.

USFWS regulations at 50 CFR § 21.15 authorize takes of migratory birds resulting from otherwise lawful military readiness activities. The definition of military readiness activities applies to the Migratory Bird Treaty Act in the same way that it applies to the MMPA, and ICEX is considered a military readiness activity for the purposes of this act. Under this regulation, the Navy must consider the potential environmental effects of its actions and assess the adverse effects of military readiness activities on migratory birds. If a Proposed Action may result in a significant adverse effect on a population of migratory bird species, the Navy shall consult with the USFWS to develop and implement appropriate conservation measures to minimize or mitigate these effects. A significant adverse effect on a population is defined as an effect that could, within a reasonable period of time, diminish the capacity of a population of a migratory bird species to sustain itself at a biologically viable level (50 CFR § 21.3). Conservation measures, as defined in 50 CFR § 21.3, include project designs or mitigation activities that are reasonable from a scientific, technological, and economic standpoint and are necessary to avoid, minimize, or mitigate the take of migratory birds or other potentially adverse impacts.

Based on the analysis herein, the Proposed Action would not result in a significant adverse effect on a population of migratory bird species. As such, consultation with the USFWS was not warranted.

CHAPTER 2 PROPOSED ACTION AND ALTERNATIVES

2.1 PROPOSED ACTION

The Navy's Proposed Action is to conduct submarine training and testing activities, which includes the establishment of a tracking range and temporary ice camps, and to conduct research in an Arctic environment. NMFS' proposed action is to issue a one-year IHA pursuant to the MMPA to authorize the non-intentional harassment of marine mammal species and stocks incidental to the Navy's activities, if all required findings and determinations can be made. NMFS' proposed action will be a direct outcome of responding to the Navy's request for an incidental take authorization pursuant to the MMPA. The submarine training and testing activities, including tracking range activities, would be conducted biennially, but a temporary ice camp would be established annually in one of two areas: either in the ice camp study area (Figure 2-1; same area as previous ICEX consultations) or on a frozen lake in Deadhorse, Alaska (Figure 2-2). An ice camp established during years without submarine activity is referred to as a "Beta camp," regardless of location. The purpose of the Navy's Proposed Action is to evaluate the employment and tactics of submarine operability in Arctic conditions. The Navy's Proposed Action would also evaluate emerging technologies, assess capabilities in the Arctic environment, and gather data on Arctic environmental conditions. The vast majority of submarine training and testing would occur near the associated ice camp, however, some submarine training and testing may occur throughout the deep Arctic Ocean basin near the North Pole, within the ICEX Study Area, which is approximately 2,753,390 km^2 (Figure 2-1). Though the Study Area is large, the area where the proposed ice camp would be located is a much smaller area, approximately 113,927 km^2 (see ice camp study area), and the camp itself would only encompass approximately 1.6 km^2 in diameter. The Proposed Action, including the construction and demobilization of an ice camp, would occur over approximately a six-week period for ICEX or over approximately one week for the Beta camp, from February through April (considered winter through early spring). The submarine training and testing and the research activities, when occurring, would occur over approximately four weeks during the six-week period for ICEX. Graywater and reverse osmosis reject water discharges would be discharged during camp operation. Neither graywater nor reverse osmosis reject water would be discharged during the construction of the ice camp. Additionally, the reverse osmosis units are not expected to be the primary means of generating freshwater, and therefore its use would be delayed until the camp is fully functional. The camp should be fully functional within five days after initial flights to drop-off equipment have been made.

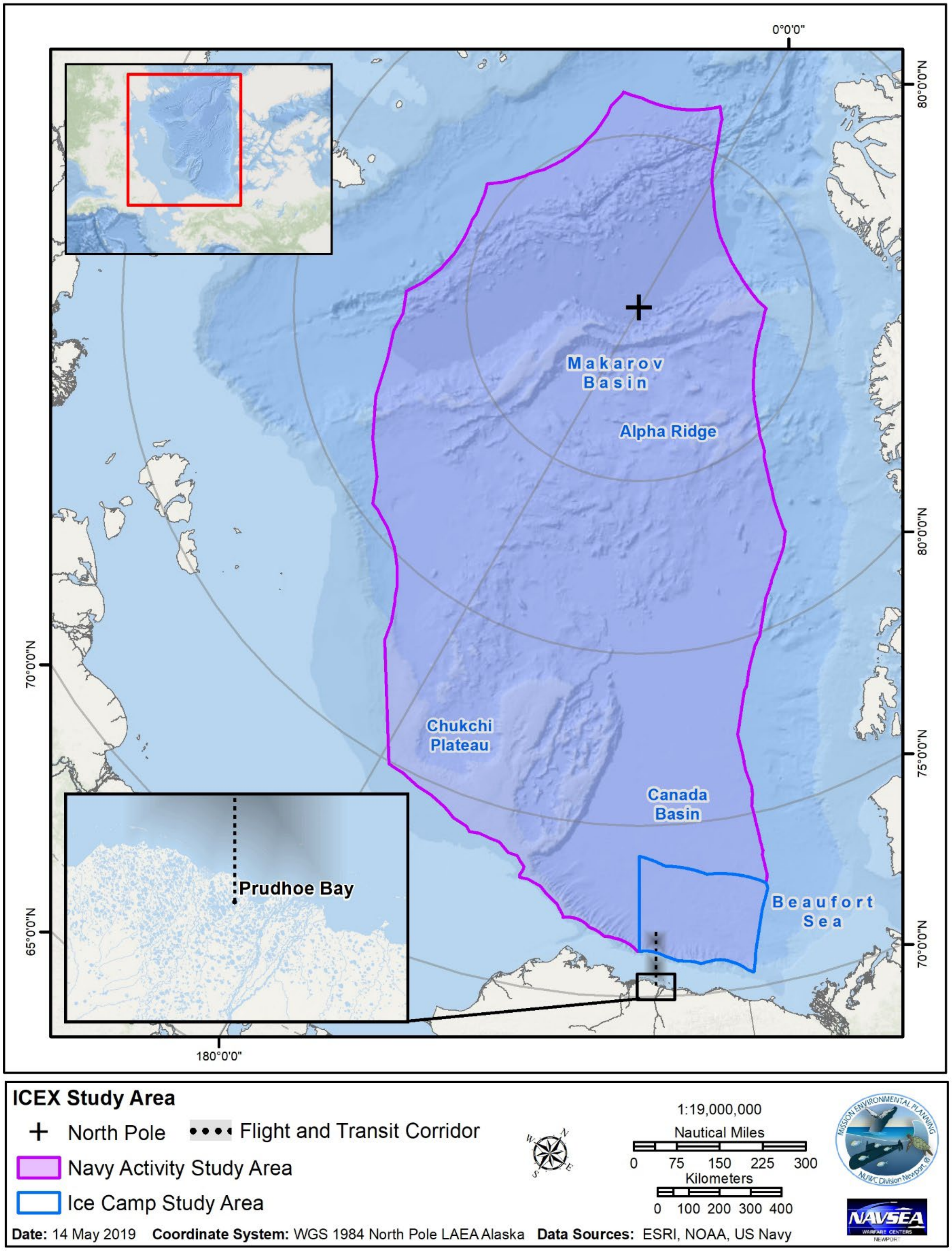


Figure 2-1. The ICEX Program Study Area

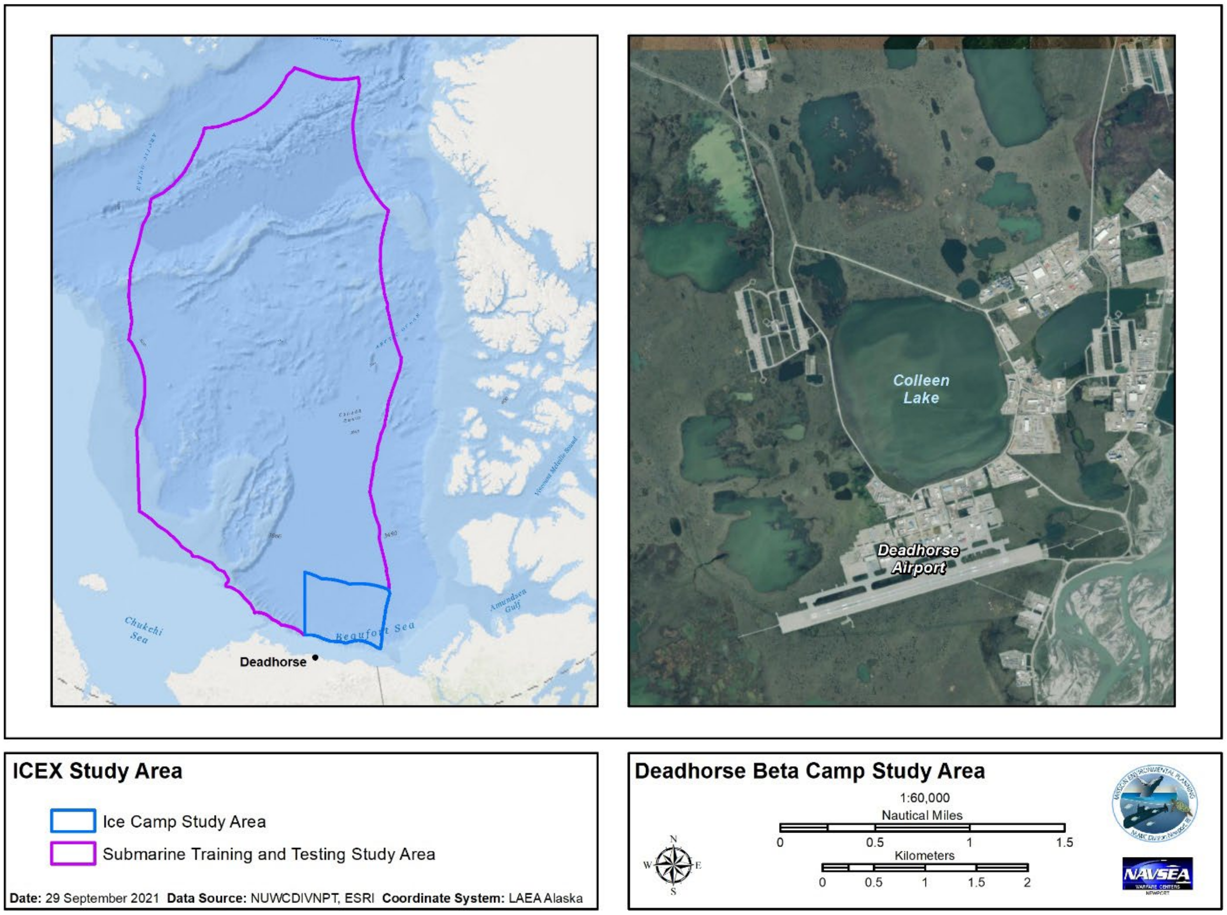


Figure 2-2. Potential Beta Camp Locations

2.1.1 Ice Camp

When constructed in support of biennial submarine exercises, 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 2-3). 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. Some tents may be octagon shaped and approximately 6 m in diameter. 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. Support equipment for the ice camp includes snowmobiles, gas powered augers and saws (for boring holes through the ice), two reverse osmosis units, and diesel generators. Beta camps are smaller in size and described further in in section 2.1.2.

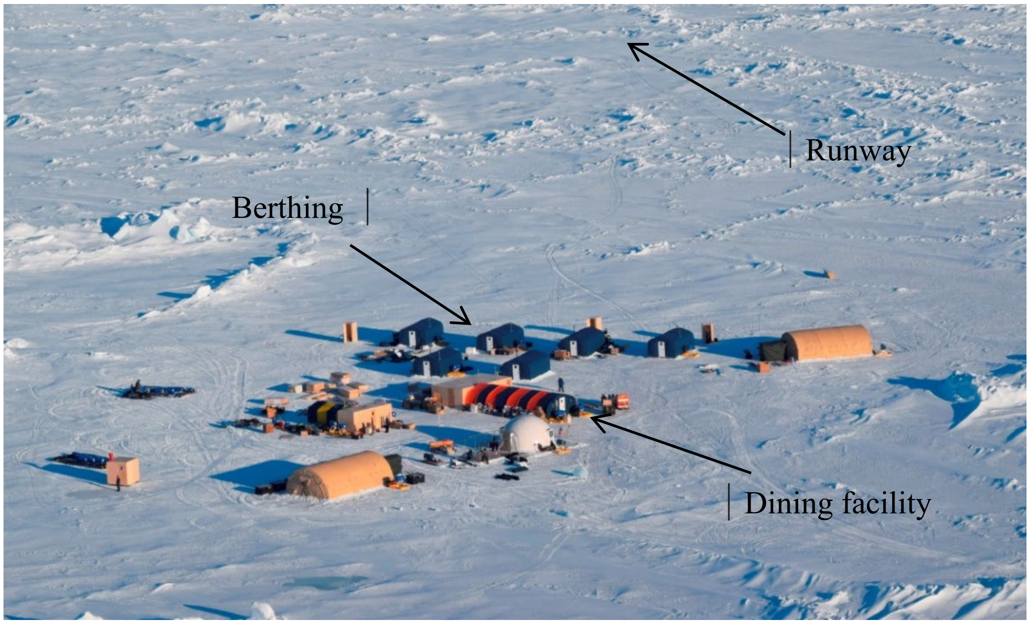


Figure 2-3. Example Ice Camp

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 (e.g., small twin-engine aircraft and military or commercial helicopters). Aircraft would be used to transport personnel and equipment from the ice camp to Prudhoe Bay; up to nine round trips could occur daily. At the completion of an ICEX event, 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 from the ice upon completion of the mission 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 an ICEX event; 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. 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. Hydrophones would be linked remotely to the command hut. Additionally, tracking pingers would be configured aboard each submarine to continuously monitor the location of the submarines. Acoustic communications with the submarines would be used to coordinate the training and research schedule with the submarines; an underwater telephone would be used as a backup to the acoustic communications. Recovery of the hydrophones is planned, however if emergency demobilization is required or the hydrophones are frozen in place and are unrecoverable, they would be left in place.

Freshwater would only be made available in the camp's dining facility. This water would be available for limited food preparation, dishwashing, and human consumption. Additionally, a hygiene station would be available at the ice camp for hand washing. The hygiene station would be located in the dining facility and consist of a gravity fed container which would provide water for hand sanitizing and/or face washing if needed. 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. 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 centimeters (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. Freeze-dried, camping style meals would be the primary form of meals, supplemented with fresh fruit, energy bars, etc. The camp would have an average discharge rate of 100 gallons per day, with a maximum discharge rate of 155 gallons per day during the two weeks of peak camp operations. The estimated total discharge from the ice camp's dining facility is 2,925 gallons.

Most freshwater for drinking and cooking would be produced by reverse osmosis through desalination. However, the camp may also utilize mining and melting of multi-year ice. 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. 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.

2.1.2 Beta Camp

Beta camps, constructed in the years when submarine activities do not occur, would be approximately 24 m by 24 m and consist of 4 to 6 tents and approximately 10 to 16 personnel on site. In addition, there would typically be a 15 m by 228 m research area. Beta camps would include three or four tents, a generator, a small ice auger, a snowmobile, a reverse osmosis unit, and fuel for heaters and the generator. The remainder of the tents would be used as auxiliary support tents.

If the Beta camp is built on an ice floe, all ice camp materials, equipment, fuel, and food would be transported from Prudhoe Bay, Alaska, and delivered by a single or twin otter aircraft, to the ice camp runway. Aircraft would be used to transport personnel and equipment from the ice camp to Prudhoe Bay; up to nine round trips could occur daily. At the completion of Beta camp, the ice camp would be demobilized, and all personnel and materials would be removed from the ice floe; all solid waste, hazardous waste, and sanitary waste would be disposed of in accordance with applicable laws and regulations.

Freshwater would be obtained either through use of a reverse osmosis unit or via ice mining, which entails collecting and melting of multi-year ice. Freshwater would only be made available in the camp’s dining facility. No shower facilities would be available at the Beta camp.

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.

If the Beta camp is built on a frozen lake near Deadhorse, all materials and equipment would be transported to the lake by vehicle. The frozen lake location is adjacent to lodging, where the majority of camp personnel would stay overnight and use dining and restroom facilities, though some personnel may stay in tents overnight for testing purposes. Flights would still occur to the Ice Camp Study Area to investigate ice floes that are being satellite tracked to help refine ice floe tracking methods. Runways would not be constructed and an ice floe would only be investigated once. All materials and equipment would be removed from the frozen lake at the end of the camp.

2.1.3 Prudhoe Bay

During the Proposed Action, flights to and from Prudhoe Bay would utilize Deadhorse Airport, a public airport located next to Prudhoe Bay. Up to nine round trips could occur daily in addition to the usual flight traffic that occurs at the airport (average of 60 flights per day). All flights would leave from Deadhorse Airport and fly directly to the ice camp. The flight and transit corridor is shown in Figure 2-1. The flight corridor is approximately 25 miles wide and is the most direct route to the camp. Additionally, exercise torpedoes (i.e., non-explosive) that are retrieved from the water column following submarine training and testing would then be transported to and processed at Prudhoe Bay. Exercise torpedoes would then be prepared for transport in accordance with existing Navy policies.

An average of 6-12 personnel would stay at the local lodging facilities during the duration of the ICEX. Since the personnel would be staying in commercial lodging facilities, they would easily be absorbed into the communities' infrastructure and would not require any additional resources. The community is set up for transient type communities and handling influxes of groups such as oil and gas employees. The additional personnel would not impact any other resources because of the minimal amount of time spent in the area and the concentration of people moving from lodging to the ice camp.

2.1.4 Submarine Training and Testing

Submarine activities associated with ICEX are classified, but generally entail safety maneuvers, active sonar use, and exercise torpedo 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. Classified descriptions of submarine training and testing activities planned for ICEX can be provided to authorized individuals upon request. Submarine training and testing involves active acoustic transmissions, which have the potential to harass marine mammals. Submarine training and testing is not associated with Beta camp events.

Torpedo exercises would be conducted in alternating ICEX events (i.e., every 4 years) with associated submarine activities. Details about torpedoes and torpedo firing are classified, and descriptions can be provided to authorized individuals upon request.

2.1.5 Research Activities

Personnel and equipment proficiency testing and multiple research and development activities would be conducted (Table 2-1). Each type of activity scheduled for ICEX including research activities and the submarine training and testing activities discussed above, has been reviewed and placed into one of seven general categories of actions (Table 2-1); these categories of actions are analyzed herein. Due to the uncertainty of extreme cold, some scheduled activities may not be able to be conducted. All researcher personnel traveling to the ice camp would be berthed at the established ice camp facilities.

Table 2-1. Summary of Training and Testing and Research Activities

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.
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 collect measurements of conductivity, temperature, and ocean/ice fluxes.
		Array	Use of acoustic arrays to collect data on ambient noise, as well as determine signal propagation through Arctic environments.
	Personnel/ Equipment Proficiency	Diving Evolutions	Diver personnel conduct cold water diving evolutions under the ice using various equipment.
		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.

2.2 PLATFORM DESCRIPTIONS

Typical platforms used for ice camp logistics and those necessary to support proposed research activities include on-ice vehicles (e.g., snowmobiles), aircraft, unmanned vehicles (both aerial and underwater), and passive devices. Although details on some specific systems are provided as examples, the general categories of platforms are analyzed for their potential effect to the environment.

2.2.1 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 during ICEX events while fewer are typically used for Beta camp (Figure 2-4). Two types of snowmobiles are typically used at the ice camp or Beta 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.

Figure 2-4. Typical On-Ice Vehicles (e.g. snowmobiles) used during ICEX

In addition to the typical snowmobiles, small unit support vehicles and all-terrain vehicles equipped with either six or eight wheels that can be used in open water (referenced herein as all-terrain tracked vehicle) (Figure 2-5) may be air-dropped to support runway construction and expeditionary forces, respectively. The small unit support vehicle is a full-tracked, articulated vehicle designed to transport personnel and equipment in all terrains. The all-terrain tracked vehicle is an 8x8 due to the amount of tires. It has a low ground pressure of 1.6 pounds per square inch and is used in sensitive habitats. The all-terrain tracked vehicle is capable of traversing in all terrains (Ontario Drive and Gear Ltd. 2017).

Expeditionary forces may use an all-terrain tracked vehicle. 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 typically have either gas or diesel engines. 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 2-5. All-Terrain Tracked Vehicle

2.2.2 Aircraft

Various fixed-wing and rotary-wing (i.e., helicopters) aircraft may be used in the conduct of an ICEX event (Figure 2-6). Shelters, personnel, and equipment would be transported to and from the ice camp via these 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.

Figure 2-6. Typical Aircraft used during ICEX

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 2-7 and Figure 2-7). 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 2-7. Military Aircraft used during an ICEX Event

Fixed-Wing Aircraft (right panel; LC-130), Rotary-Wing Aircraft (left panel; CH-47) and V-22 (lower left and right)

2.2.3 Unmanned Underwater Vehicles and Systems

Unmanned underwater vehicles would either maneuver autonomously, or may be tethered to a command center (Figure 2-8). 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 use active acoustic sources. Details for the active sources described above can be found in Section 2.2.4. Additionally, some unmanned underwater vehicles would have *de minimis* sources used and deployed throughout ICEX which are not discussed further in this document. *De minimis* sources 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).

Figure 2-8. Example Unmanned Underwater Vehicles
(Top panel is a Remote Environmental Monitoring Unit System 100; bottom left is a 21" Bluefin; bottom center is a LBV300; bottom right is the tether associated with the LBV300, resulting in a Tethered, Hovering Autonomous Underwater System)

In addition to unmanned underwater vehicles, various unmanned aerial systems are proposed for testing. Systems used may be either fixed-wing (Figure 2-9) or rotary-wing (Figure 2-10). 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.

Figure 2-9. Example Fixed-wing Unmanned Aerial System
(Left panel is launch; center panel is in flight; right panel is recovery)

Figure 2-10. Example Rotary-wing Unmanned Aerial Systems

2.2.4 Scientific Devices

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

2.2.4.1 Passive Devices

A vertical line array would be deployed through the ice to measure ambient underwater noise and sound propagation through Arctic waters. A tow body consisting of plate weights suspended from a line would be deployed through the ice to disturb the fine-scale ocean “staircase” structure at 200-300 m. A line array of oceanographic sensors would measure any noticeable difference in the ambient area from the deployment of this tow body line. This array would contain a series of acoustic recorders located at depths from the surface to 200 m. Other various scientific devices (typically less than 1 m in diameter) would be deployed throughout the ICEX events, including four EMATTS (mobile acoustic sources) which will transmit in specific patterns within the mixed arctic water layer, for the vertical line arrays to receive. EMATTS would scuttle and would not be retrieved. 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 (Figure 2-11).

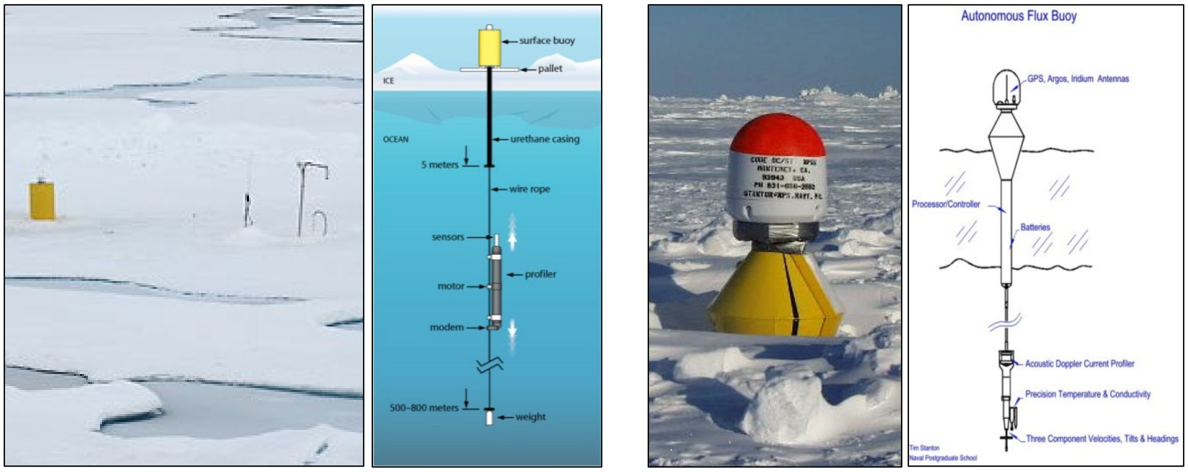


Figure 2-11. Example Passive Devices (Buoys)
(left panels are Ice Tethered Profiler; right panels are Ocean Flux Buoy)

2.2.4.2 Active Acoustic Devices

One active ice profiler would be deployed under the ice to map the ice. Acoustic parameters for active sources described above can be found in Table 2-2.

Table 2-2. Parameters of Scientific Devices with Active Acoustics

Research Institution	Source Name	Frequency Range (kHz)	Source Level (dB)	Pulse Length (milli-seconds)	Source Type
Naval Postgraduate School	Atlas	125	212	1-20	Ice Profiler

2.3 ALTERNATIVES

Screening criteria were used in the development and selection of alternatives. These criteria were developed based upon training and testing requirements, as well as geographic and temporal limitations associated with the Arctic. Screening criteria for the selection of alternatives include:

(1) ICEX and Beta camps must be conducted during a time of year when there are sufficient hours of daylight to support several hours of training and testing each day;

(2) The off-shore training location must be on a large area of stable ice that does not have (and is not likely to develop) open leads or “gaps” and can sustain a runway and a camp for several weeks;

(3) The off-shore location must have sufficient water depth to accommodate safe submarine activities, and;

(4) The off-shore location must be in sufficient proximity to shore logistics centers to allow for transfers of personnel and equipment to and from the ice camp or Beta camp.

Based on these screening criteria, a No Action Alternative and two Action Alternatives will be addressed herein.

2.3.1 No Action Alternative

Under the No Action Alternative, no actions under the ICEX program would occur. The Navy would not establish an ice camp and would not conduct submarine training and testing activities or research in the Arctic. This alternative requires no subsequent analysis of potential consequences to environmental resources, as no action would occur.

2.3.2 Alternative 1: ICEX events (supporting submarine testing and training) conducted biennially with torpedo exercise every four years.

Under Alternative 1, the Navy would establish an ice camp to support submarine training and testing. The ice camp would be established approximately 100–200 nm north of Prudhoe Bay, Alaska; the exact location cannot be identified in advance, as many of the required conditions (e.g., ice cover) cannot be forecasted until around the time when the exercises are expected to commence. The vast 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 Study Area (Figure 2-1). Though the Study Area is large, the area where the proposed ice camp would be located is a much smaller area (see ice camp proposed action area on Figure 2-1). Prior to the set-up of the ice camp, reconnaissance flights would be conducted to locate suitable ice conditions required for the location of the ice camp. The reconnaissance flights would occur over an area of approximately 70,374 square kilometers (km^2); the actual ice camp is no more than 1.6 km in diameter (approximately 2 km^2 in area).

The Navy's Proposed Action would occur over an approximately six week period biennially from February to April, including construction and demobilization of the ice camp. The submarine training and testing would occur over approximately four weeks during the six-week period in alternating years only. Every four years, torpedo exercises (TORPEX) would occur in the vicinity of the ice camp with support at Prudhoe Bay.

2.3.3 Alternative 2: ICEX events conducted biennially with a Beta camp constructed either on ice floe or in Deadhorse, Alaska in alternate years.

Under Alternative 2, the Navy would conduct all activities, as described under Alternative 1, which includes submarines training and testing (including torpedo exercises every four years), construction of an ice camp and research activities, on a biennial schedule as well as construction of a smaller "Beta" ice camp in the alternate years, either on an ice floe or on a frozen lake in Deadhorse, Alaska.

2.3.4 NMFS Action Alternative

Under the NMFS Action Alternative, NMFS would grant a one-year IHA to the Navy for the incidental, not intentional, harassment of marine mammals species or stocks caused by the Navy's ICEX activities, provided that all findings and required determinations could be made.

NMFS' action alternative is to issue a one-year IHA pursuant to the MMPA for the harassment of marine mammals incidental to specified activities associated with the Navy's ICEX activities. NMFS received an application on August 26, 2021 for an IHA for the harassment of marine mammals (ringed seals and bearded seals) incidental to training and testing activities (i.e., active acoustic transmissions) occurring over a six-week period in 2022.

2.3.5 Alternatives Eliminated from Further Consideration

Other action alternatives considered but not carried forward for detailed analysis include geographic, seasonal, and operational variations. As discussed in the screening criteria (Section 2.3), holding ICEX events in a different location (i.e. Study Area), or at a different time of year, would not satisfy the purpose and need. For example, holding ICEX events closer to shore would not afford sufficiently thick ice to support an ice camp as well as the submarine tracking range to conduct the required submarine training and testing. Additionally, submarines need a relatively deep depth in which to operate. Positioning the camp further from shore would put the camp beyond the reach of logistics support required to sustain the activity. Not constructing and testing equipment for a Beta Camp would not allow new technologies to be tested before a longer duration use in the ICEX event. Seasonal alternatives are likewise not feasible because the combination of ice conditions and sufficient daylight required to support the ice camp are only available in the timeframe identified for the Proposed Action. Additionally, any alternative that restricted acoustic transmissions, aircraft movement, or prescribed time restrictions would not allow the Navy to meet its training requirements and therefore, would not satisfy the purpose and need.

Finally, altering how submarine training and testing is conducted (e.g., reducing source level or limiting duration) is not feasible because the training and test plans are designed to specifically meet or test certain objectives. Conducting the training and testing differently would not meet the purpose and need of these requirements. Therefore, the Study Area identified in Figure 2-1 is the only suitable location, February through April is the only suitable timeframe, and the Proposed Action must be conducted as proposed to meet training and testing objectives.

2.4 RESOURCE ANALYSIS

As part of the process to determine the potential impact from the Proposed Action, the Navy identified potential resources and issues to be analyzed (Table 2-3). Table 2-4 lists the resources eliminated from further analysis and provides an explanation for their dismissal. Elimination may be due to geographic location or seasonality of ICEX events.

Table 2-3. Relevant Resources and Potential Effects of the Proposed Action

Resource	***Potential Stressors***
Physical Environment	
Air Quality	The Proposed Action would generate air emissions from mobile generators, aircraft, and on-ice vehicles. The ice camp would be located outside of the jurisdictional limit of the Clean Air Act. Therefore, the conformity rule does not apply, and the Proposed Action is not subject to a conformity analysis. Prudhoe Bay falls within in the North Slope attainment area, therefore, Prudhoe Bay is not subject to a conformity analysis.
Water Quality	Human presence (e.g., graywater discharge) and combustive byproducts (from exercise torpedoes) have the potential to impact water quality.
Biological Environment	
Invertebrates	Acoustic transmissions, in-water vessel and vehicle strike, bottom disturbance, combustive byproducts (from exercise torpedoes), entanglement, and ingestion have the potential to impact invertebrates.
Marine birds	Aircraft noise, on-ice vehicle noise, aircraft strike, and ingestion have the potential to impact marine birds.
Fish	Acoustic transmissions, in-water vessel and vehicle strike, bottom disturbance, combustive byproducts (from exercise torpedoes), entanglement, and ingestion have the potential to impact fish.
Essential Fish Habitat	Human presence (e.g. graywater discharge) and combustive byproducts (from exercise torpedoes) have the potential to affect Essential Fish Habitat.
Mammals	Acoustic transmissions, aircraft noise, on-ice vehicle noise, on-ice vehicle strike, in-water vessel and vehicle strike, human presence, combustive byproducts (from exercise torpedoes), entanglement, and ingestion have the potential to impact marine mammals. Aircraft noise, on-ice vehicle noise, on-ice vehicle strike, human presence, entanglement and ingestion have the potential to impact the Arctic fox.
Socioeconomic Environment	
Subsistence Hunting	The Proposed Action has the potential to temporarily impact species which are used in subsistence hunting. Subsistence hunting itself would not be stopped or interrupted as part of the Proposed Action due to the distance from shore where the majority of actions would occur.

Table 2-4. Resources Eliminated from Analysis

Resource	Reason for Elimination
Physical Environment	
Airspace	The majority of Proposed Action would occur in the open ocean or on the ice surface. Aircraft would depart from Deadhorse Airport in Prudhoe Bay, but with a maximum of nine flights per day at the height of the exercise, would not have an impact to airspace use. All flights would be coordinated with the airport and would not create undue congestion of airspace. Low flying aircraft may be used for a portion of the training and testing but would not interfere with regular public airspace usage given that the offshore location is not a frequently used flight corridor. Therefore, the Proposed Action would not impact use of airspace.
Floodplains and Wetlands	The Proposed Action would occur in open water and would not impact the physical attributes of floodplains or wetlands. Therefore, the Proposed Action would not impact floodplains or wetlands.
Geology	No construction or dredging is planned as part of the Proposed Action. Therefore, the Proposed Action would not impact geological resources.
Land Use	The Proposed Action would occur in offshore of Prudhoe Bay, Alaska on ice-covered water or on a frozen lake and not on land. Therefore, the Proposed Action would not impact land use.
Terrestrial Environment	The Proposed Action would occur offshore, except for aircraft flights from Deadhorse Airport, in Prudhoe Bay. Because the Proposed Action would take place during the winter and early spring no biological resources would be present within the Deadhorse Airport boundaries, in Prudhoe Bay, so further analysis of these terrestrial resources are not included. Therefore, the Proposed Action would not impact the terrestrial environment including parks, forests, and prime and unique farmland.
Wild and Scenic Rivers	The Proposed Action would occur on or in ocean waters or a frozen lake. Therefore, the Proposed Action would not impact wild and scenic rivers.
Biological Environment	
Terrestrial Wildlife	With the exception of the Arctic fox, no other terrestrial wildlife is anticipated to occur at the ice camp. Therefore, no impact would occur to these species.
Invasive Species	No invasive species would be introduced into the area because research equipment is brought up to the ice camp dry and clean. Additionally, the harsh environmental conditions and freezing cold would likely kill exposed organisms during shipping. No research equipment is planned for Beta camp testing.
Deep Sea Corals and Coral Reefs	No deep sea corals or coral reefs are present in the Study Area. Therefore, no impact would occur to these species.
Marine Vegetation	Marine vegetation is present within the Study Area, however because of the limited amount of human presence and limited chance for interaction with marine vegetation due to the ice camp being above the ice, there would be no impact to marine vegetation.
Sea Turtles	No sea turtles would be present in the Study Area. Therefore, no impact would occur to these species.
Socioeconomic Environment	
Aesthetics	Aircraft movements out of the Deadhorse Airport, in Prudhoe Bay would be consistent with the typical flights coming in and out of the airport. Vessel movements would be at least 100-150 nautical miles (nm) from shore and would be under the ice in the Study Area. Therefore, the Proposed Action would not impact aesthetics.
Archaeological and Historical Resources	No known archaeological or historical resources are located within the Study Area. Therefore, the Proposed Action would not impact archaeological and historical resources.
Commercial and Recreational Fisheries	There are no commercial or recreational fisheries near or in the Study Area. Therefore, the Proposed Action would not impact commercial and recreational fisheries.

Resource	Reason for Elimination
Commercial Shipping and Transportation	Although, there is a shipping lane in the Study Area (i.e. Northwest Passage) it is only used during late July through mid-October (depending on the route and year). Since this is outside of the timeframe of the Proposed Action there would be no impact to commercial shipping and transportation.
Cultural Resources	The Study Area is offshore of known cultural resources.
Environmental Justice	The Proposed Action would occur on and in the open ocean and the majority of the action would occur offshore. There would be no disproportionately high or adverse human health or environmental impacts on minority or low-income populations. Additionally, Prudhoe Bay does not have a minority of low income population. Therefore, the Proposed Action would not impact environmental justice.
Infrastructure	No modification of infrastructure would occur as a result of the Proposed Action. Therefore, the Proposed Action would not impact infrastructure.
Recreational Boating and Tourism	During the timeframe of the Proposed Action there would be no recreational boating and tourism in the Study Area. Therefore, the Proposed Action would not impact recreational boating and tourism.
Utilities	The Proposed Action would not occur near any utilities. Therefore, the Proposed Action would not impact utilities.

CHAPTER 3 EXISTING ENVIRONMENT

3.1 PHYSICAL ENVIRONMENT

The Study Area for the Proposed Action is primarily located within the Beaufort Sea, where the ice camp study area is located, but extends northward and encompasses the North Pole where submarine activities would occur, but also includes Deadhorse, AK, where the Beta ice camp may be constructed. Additionally, the Proposed Action includes flights to and from Deadhorse Airport, and the use of the Deadhorse Aviation Center Hangar and other facilities in Prudhoe Bay, Alaska.

Prudhoe Bay, Alaska falls within the North Slope Borough, encompassing approximately 1,425 km^2. The area that would be utilized for ICEX falls directly between Nuiqsut and Kaktovik along the Beaufort Sea. Based on the 2020 North Slope Borough Economic Profile and Census Report, the population of Prudhoe Bay is roughly 2,200, though at any given time there are several thousand transient workers supporting the Prudhoe Bay oil field, the largest in the United States (North Slope Borough 2020).

3.1.1 Water Quality

The high Arctic waters (a term used to describe barren polar areas) have water of relatively low nutrient loads. At the end of the winter, a burst of primary productivity occurs under the ice when light levels become sufficiently high and nutrients are released from the ice. This surge of nutrients includes nitrogen (as ammonium, nitrite, and nitrate), phosphorus (as phosphate), iron, and other elements, which would then be either grazed upon and move through the food chain, or sink to the bottom and incorporate into bottom sediments (Vancoppenolle et al. 2013). In polar waters, nutrient concentrations undergo seasonal depletion in surface waters due to photosynthesis during spring/summer and renewal during winter when photosynthesis stops (Whitledge et al. 2008).

3.1.2 Air Quality and Greenhouse Gases

Air quality is defined by ambient concentrations of specific air pollutants – pollutants the U.S. Environmental Protection Agency (USEPA) determined may affect the health or welfare of the public. The six major pollutants of concern are called "criteria pollutants" and include carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, suspended particulate matter (dust particles less than or equal to 10 microns in diameter particulate matter [PM_{10}] and fine particulate matter less than or equal to 2.5 microns in diameter [$PM_{2.5}$]), and lead. The USEPA established National Ambient Air Quality Standards (NAAQS) for these criteria pollutants.

Air pollutants are classified as either primary or secondary pollutants based on how they originate in the atmosphere. Primary air pollutants are emitted directly into the atmosphere from the source of the pollutant and retain their chemical form. Examples of primary pollutants are the ash produced by burning solid waste and volatile organic compounds emitted from a dry cleaner (U.S. Environmental Protection Agency 2010). Secondary air pollutants are those formed through atmospheric chemical reactions – reactions that usually involve primary air pollutants (or pollutant precursors) and normal constituents of the atmosphere (U.S. Environmental

Protection Agency 2010). Ozone, a major component of photochemical smog, is a secondary air pollutant. Ozone precursors fall into two broad groups of chemicals: nitrogen oxides and organic compounds. Nitrogen oxides consist of nitric oxide and nitrogen dioxide. Organic compound precursors of ozone are routinely described by various terms, including volatile organic compounds, reactive organic compounds, and reactive organic gases. Finally, some air pollutants are a combination of primary and secondary pollutants. PM_{10} and $PM_{2.5}$ are generated both as primary pollutants by various mechanical processes (e.g., abrasion, erosion, mixing, or atomization) or combustion processes. They are generated as secondary pollutants through chemical reactions or through the condensation of gaseous pollutants into fine aerosols.

NAAQS are set for criteria pollutants. Areas that exceed a standard are designated as "nonattainment" for that pollutant, while areas in compliance with a standard are in "attainment" for that pollutant. An area may be nonattainment for some pollutants and attainment for others simultaneously. States, through their air quality management agencies, are required to prepare and implement State Implementation Plans for nonattainment areas, which demonstrate how the area will meet the NAAQS. Areas that achieved attainment may be designated as "maintenance areas," subject to maintenance plans showing how the area will continue to meet federal air quality standards. Nonattainment areas for some criteria pollutants are further classified, depending on the severity of their air quality problem, to facilitate their management:

- Ozone – marginal, moderate, serious, severe, and extreme
- Carbon monoxide – moderate and serious
- Particulate matter – moderate and serious

The USEPA delegates the regulation of air quality to the state once the state has an approved State Implementation Plan. The Clean Air Act of 1970 also allows states to establish air quality standards more stringent than the NAAQS.

3.1.2.1 Greenhouse Gases

Greenhouse gases (GHGs) are gas emissions that trap heat within the atmosphere. These emissions occur from both natural processes and human activities. Scientific evidence indicates a trend of increasing global temperature over the past century due to an increase in GHG emissions from human activities. The climate change associated with this global warming is predicted to produce negative economic and social consequences across the globe.

The USEPA has identified greenhouse gases as carbon dioxide, methane, nitrogen oxide, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and other fluorinated gases including nitrogen trifluoride and hydrofluorinated ethers. Each GHG is assigned a global warming potential. The global warming potential is the ability of a gas or aerosol to trap heat in the atmosphere; this rating system is standardized to carbon dioxide, which has a value of one. The equivalent carbon dioxide rate is calculated by multiplying the emissions of each GHG by its global warming potential and adding the results together to produce a single, combined emissions rate representing all GHGs.

3.1.2.2 Affected Environment

The Study Area spans from the northern coastline of Alaska to the area surrounding the North Pole. The majority of the Study Area, including the ice camp proposed action area, is substantially offshore and beyond state boundaries; outside of 12 nm, attainment status is not applicable and the Clean Air Act NAAQS do not apply. However, given fluctuations in wind direction, air quality in adjacent onshore areas may be affected by releases of air pollutants from Study Area sources. Therefore, NAAQS attainment status of adjacent onshore areas is considered in determining whether appropriate controls on air pollution sources in the adjacent offshore state waters is warranted. All coastal Alaska boroughs and counties are classified as attainment areas of the eight-hour standard for ozone (40 CFR § 81.322). As previously mentioned, attainment areas are areas that meet the NAAQS for specific pollutants. Under the Clean Air Act, only nonattainment areas are required to limit and act to decrease emissions below the NAAQS. Since the Study Area is not adjacent to nonattainment areas, there are not limitations placed on emissions.

The primary concern with regards to GHGs for ICEX comes from flights to and from the ice camp. These flights would be small aircraft departing from an existing airfield, and therefore would not lead to emissions levels of concern. Increases in daily flights operating out of the Deadhorse Airport, in Prudhoe Bay, due to the ICEX activity are not expected to significantly contribute to greenhouse gas emissions in the area during the temporary timeframe of the Proposed Action. The remainder of ICEX activities, including the use of generators, would occur more than 12 nm from shore, where NAAQS do not apply.

3.1.3 Sea Ice

3.1.3.1 Arctic Sea Ice Regime

Sea ice is frozen seawater that floats on the surface of the ocean, covering millions of square miles. Sea ice that persists year after year, surviving at least one summer melt season, is known as multiyear ice. Sea ice forms and melts with polar seasons and affects both human activity and biological habitat (Jeffries et al. 2014). Arctic sea ice plays a crucial role in Northern Hemisphere climate and ocean circulation, and is thought to play an even more crucial role in regulating climate than Antarctic sea ice (National Snow and Ice Data Center 2007; Serreze et al. 2003).

Sea ice directly impacts coastal areas and broadly affects surface reflectivity, ocean currents, water cloudiness, humidity, and the exchange of heat and moisture at the ocean’s surface. Since sea ice reflects the sun’s heat, when ice retreat is greater and there is more open ocean, more of the sun’s heat is absorbed, increasing the warming of the water (Timmermans and Proshutinsky 2014).

3.1.3.2 Sea Ice Extent

Though the record of sea ice extent dates as far back as 1900 in the Northern Hemisphere, the most complete record of sea ice is provided by microwave satellites, which have routinely and accurately monitored sea ice extent since 1979 (Jeffries et al. 2014; Timmermans and Proshutinsky 2014). Annually, sea ice extent is at its maximum in March, representing the end of winter, and is at its minimum in September (Jeffries et al. 2014). During the Proposed Action, the southerly extent of sea ice is located within the Bering Sea (Figure 3-1); the entire Study Area would be covered by sea ice during the Proposed Action.

Data from 2020 reveals a minimum extent of 3.82 million km^2. This extent is on record as the second lowest minimum ice extent on record (National Snow and Ice Data Center 2021). September 2012 remains the record low minimum ice extent of 3.4 million km^2 (National Snow and Ice Data Center 2017). In September of 2007, the sea ice recession was so vast that the Northwest Passage completely opened up for the first time in human memory (National Snow and Ice Data Center 2007).

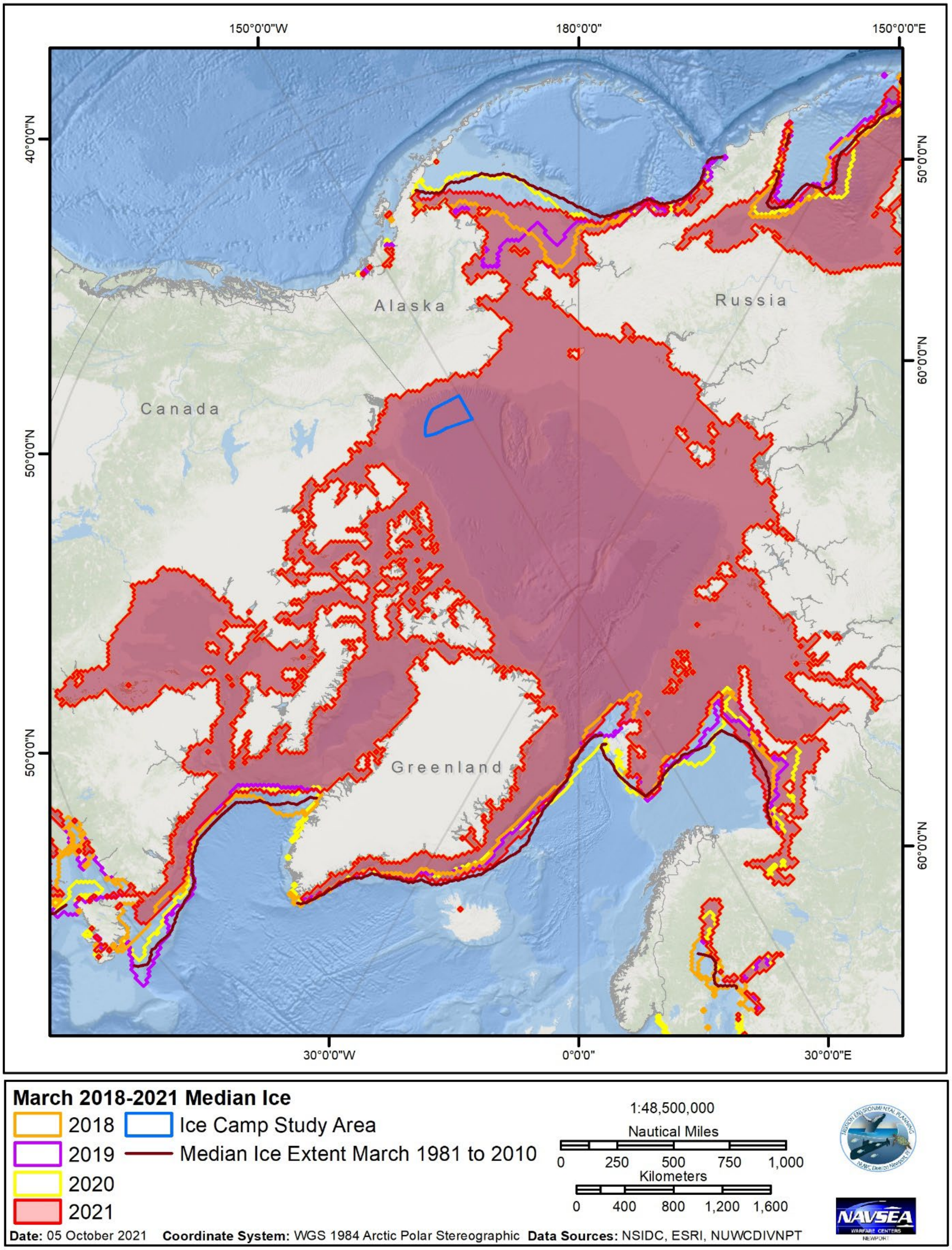


Figure 3-1. Average Arctic Sea Ice Extent in March

The age of the sea ice is another key descriptor of the state of the sea ice cover, as it is an indicator for its physical properties including surface roughness, melt pond coverage, and ice thickness. Older ice tends to be thicker and thus more resilient to changes in atmospheric and oceanic forcing than younger ice. The age of the ice can be determined using satellite observations and drifting buoy records to track ice parcels over several years (Tschudi et al. 2010). The distribution of ice of different ages illustrates the extensive loss in recent years of the older ice types (Maslanik et al. 2011). In 2014, the distribution of ice age favored first-year ice, or ice that has not survived a melt season. This is the thinnest type of ice. The month of March has shown a decreasing trend in the oldest ice, which is 4 years old or older. In 1988, 26 percent of ice cover was the oldest ice. The oldest ice cover decreased to 19 percent in 2005 and to 10.1 percent in 2014, which has increased slightly from 2013 (Perovich et al. 2013). Sea ice has also been experiencing later freeze-up than usual and earlier ice melt over the past few years, leading to a decline in multiyear ice, although there was an increase in multi-year ice seen from 2013 to 2014 (Overland and Wang 2013). In March of 2014, the coverage of multi-year ice increased to 31 percent of ice cover. In March of 2013, the coverage was only 22 percent. The mean thickness of this ice, measured northwest of Greenland, also increased: 2.35 m in March of 2014 compared to 1.97 m in March of 2013.

Sea ice extent fluctuates annually and is influenced by natural variations in atmospheric pressure and wind patterns, but clear linkages have also been made to decreased Arctic sea ice extent and rising greenhouse gas concentrations dating back to the early 1990s (Timmermans and Proshutinsky 2014). A general downward trend in Arctic sea ice has occurred during the last few decades (Serreze et al. 2003). The maximum ice extent from March 2016 tied with March 2014 for the lowest maximum ice extent in the 37-year satellite record (14.76 million km^2). This maximum extent is 5 percent below the 1981 through 2010 average, though fairly typical of measurements taken in the last decade (Perovich et al. 2013). The March 2015 maximum extent measured 4.52 million km^2 (National Snow and Ice Data Center 2017). The ice is declining faster than computer models had projected, and this downward trend is predicted to continue (National Snow and Ice Data Center 2007; Timmermans and Proshutinsky 2014). The decrease in sea ice extent can be seen in Figure 3-2 below, illustrating the decline in sea ice during the month of March between 1979 and 2016, estimated to be approximately a 3.2 percent decrease per decade (National Snow and Ice Data Center 2017).

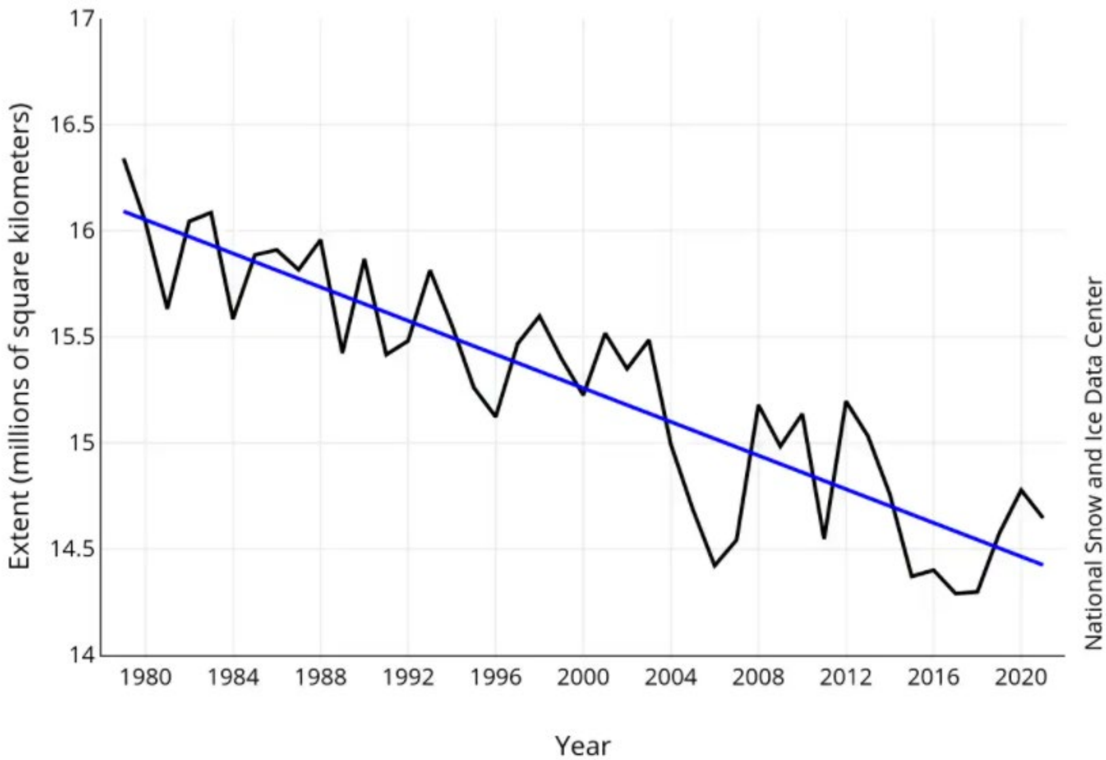


Figure 3-2. Average Arctic Sea Ice Extent for March (1979-2012)

3.2 Biological Environment

3.2.1 Invertebrates

Marine invertebrates occur in the world's oceans, from warm shallow waters to cold deep waters, and are the dominant animals in all habitats of the Study Area. Excluding microbes, approximately 5,000 known marine invertebrates have been documented in the Arctic; the number of species is likely higher, though, since this area is not well studied (Josefson et al. 2013). Although most species are found within the benthic zone, marine invertebrates can be found in all zones (sympagic [within the sea ice], pelagic [open ocean], or benthic [bottom dwelling]) of the Beaufort Sea (Josefson et al. 2013). Marine invertebrate distribution in the Beaufort Sea is influenced by habitat and oceanographic conditions (e.g., depth, temperature, salinity, nutrient concentrations, and ocean currents) (Levinton 2009). The cold water of the Arctic generally results in slow growth and high longevity among invertebrates and food sources which are only seasonally abundant. Major taxonomic groups found within the Beaufort Sea are listed and described in Table 3-1, since no studies of invertebrates have been completed within the Study Area. No ESA-listed species of invertebrates exist within the Study Area. Additionally, Essential Fish Habitat has not been designated for any federally managed invertebrate species within the Study Area.

Table 3-1. Taxonomic Groups of Marine Invertebrates in the Beaufort Sea

Invertebrate Group		*Presence in Beaufort Sea*		
Common Name (Taxonomic Group)	***Description***	***Sympagic***	***Pelagic***	***Benthic***
Flatworms (Phylum Platyhelminthes)[1]	Simplest form of marine worm with a flattened body.	✓		✓
Ribbon worms (Phylum Nemertea)[1]	Worms with a long extension from the mouth (proboscis) that helps capture food.		✓	✓
Roundworms (Phylum Nematoda)[1]	Small worms; many live in close association with other animals (typically as parasites).	✓	✓	✓
Sponges (Phylum Porifera)[2]	Large species have calcium carbonate or silica structures embedded in cells to provide structural support.			✓
Segmented worms (Phylum Annelida)[2]	Highly mobile marine worms; many tube-dwelling species.	✓	✓	✓
Bryozoans (Phylum Bryozoa)[3]	Lace-like animals that exist as filter feeding colonies. Form either encrusting or bushy-tuftlike lacy colonies.			✓
Hydroids and jellyfish (Phylum Cnidaria)[2]	Animals with stinging cells.	✓	✓	✓
Cephalopods, bivalves, sea snails, chitons (Phylum Mollusca)[2]	Mollusks are a diverse group of soft-bodied invertebrates with a specialized layer of tissue called a mantle. Mollusks such as squid are active swimmers and predators, while others such as sea snails are predators or grazers and clams are filter feeders.		✓	✓
Shrimp, crab, barnacles, copepods (Phylum Arthropoda – Crustacea)[2]	Diverse group of animals, some of which are immobile. Most have an external skeleton. All feeding modes from predator to filter feeder.	✓	✓	✓
Sea stars, sea urchins, sea cucumbers (Phylum Echinodermata)[2]	Predators and filter feeders with tube feet.			✓

[1]Based on Arctic Ocean biodiversity (Bluhm 2008), and due to lack of information on phyla species added for analysis (presence within the Study Area is unknown).
[2]Invertebrate phyla are based on the World Register of Marine Species (Appeltans et al. 2010) and Catalogue of Life (Bisby et al. 2014).
[3]Phyla not extracted when searched the distribution of the Beaufort Sea on the World Register of Marine Species. Individual species found on Arctic Ocean biodiversity, and verified via the distribution maps on the World Register of Marine Species (Appeltans et al. 2010)

3.2.1.1 Invertebrate Hearing

Hearing capabilities of invertebrates are largely unknown (Lovell et al. 2005; Popper and Schilt 2008). Outside of studies conducted to test the sensitivity of invertebrates to vibrations, very little is known on the effects of anthropogenic underwater noise on invertebrates (Edmonds et al. 2016). While data are limited, research suggests that some of the major cephalopods and decapods may have limited hearing capabilities (Hanlon 1987; Offutt 1970), and may hear only low-frequency (less than 1 kHz) sources (Offutt 1970; Packard et al. 1990), which is most likely within the frequency band of biological signals (Hill 2009). Both behavioral and auditory brainstem response studies suggest that crustaceans may sense frequencies up to three kilohertz (kHz), but best sensitivity is likely below 200 hertz (Hz) (Goodall et al. 1990; Lovell et al. 2005; Lovell et al. 2006). Most cephalopods likely sense low-frequency sound below 1,000 Hz, with best sensitivities at lower frequencies (Budelmann 2010; Mooney et al. 2010; Offutt 1970; Packard et al. 1990). A few cephalopods may sense higher frequencies up to 1,500 Hz (Hu et al. 2009).

3.2.2 Marine Birds

For the purpose of this document, “marine birds” refers to shoreline, coastal, bay, and pelagic bird species. A description is provided below for each of the major taxonomic group of marine birds that occur in the Study Area and include species protected under the Migratory Bird Treaty Act. No ESA-listed bird species exist within the Study Area. A combination of short-distance migrants, long-distance migrants, and year-round resident marine bird species occur within the Study Area, although during the timeframe of the Proposed Action only year-round residents would be present. Typical behaviors that would be encountered within the Study Area predominantly include on-ice foraging and migrating.

3.2.2.1 Major Bird Groups

Five species of birds may occur within the Study Area during the Proposed Action. All species listed in Table 3-2 have a year-round seasonality in the Beaufort Sea and surrounding region. All other Beaufort Sea bird species are only encountered in the summer season when they migrate from their southern wintering grounds to their northern breeding grounds in the Arctic.

Table 3-2. Marine Bird Species that May Occur in the Study Area during the Proposed Action

Common Name	***Scientific Name***	***Seasonal Presence within the Study Area****	***Distribution within the Study Area***
Order Charadriiformes			
Family Laridae			
Ivory gull	*Pagophila eburnea*	Year-round	In-shore near Prudhoe Bay, edges of pack ice
Ross’s gull	*Rhodostethia rosea*	Year-round	Prudhoe Bay or ice camp
Order Procellariiformes			
Family Phasianidae			
Rock Ptarmagan	*Lagopus muta*	Year-round	Prudhoe Bay, land based
Family Procellariidae			
Northern fulmar	*Fulmarus glacialis*	Year-round	Prudhoe Bay or ice camp
Short-tailed shearwater	*Puffinus tenuirostris*	Year-round	Prudhoe Bay or ice camp

*All seasonality information was obtained from International Union for the Conservation of Nature (2016) and Cornell Lab of Ornithology (2016).

ESA-listed spectacled eiders (*Somateria fischeri*) and Steller’s eiders (*Polysticta stelleri*) use the Arctic coastal plains in northern Alaska for breeding, which includes the area around Prudhoe Bay. However, both species overwinter in the Bering Sea and Gulf of Alaska, so would not be present near any ICEX activities.

3.2.2.2 Hearing

Although hearing range and sensitivity has been measured for many terrestrial birds, little research has been conducted on the hearing capabilities of marine birds. The majority of published literature on bird hearing focuses on terrestrial birds, particularly songbirds, and their ability to hear in the air. A review of 32 terrestrial and marine species reveals that birds generally have greatest hearing sensitivity between 1 and 4 kHz (Beason 2004; Dooling 2002). Research shows that very few birds can hear below 20 Hz, most have an upper frequency hearing limit of 10 kHz, and none exhibit the ability to hear frequencies higher than 15 kHz (Dooling 2002; Dooling et al. 2000). Hearing capabilities have been studied for only a few marine birds (Beason 2004; Beuter et al. 1986; Thiessen 1958; Wever et al. 1969); these studies show that marine birds have hearing ranges and sensitivities that are consistent with what is currently known about general bird hearing capabilities.

3.2.3 Fish

The fish species located in the Study Area include those that are closely associated with the deep ocean habitat of the Beaufort Sea. Nearly 250 marine fish species have been described in the Arctic, excluding the larger parts of the sub-Arctic Bering, Barents, and Norwegian Seas (Mecklenburg et al. 2011). However, only about 30 are known to occur in the Arctic waters of the Beaufort Sea (Christiansen and Reist 2013). Largely because of the difficulty of sampling in remote, ice-covered seas, many high-Arctic fish species are known only from rare or geographically patchy records (Mecklenburg et al. 2013). Aquatic systems of the Arctic undergo extended seasonal periods of ice cover and other harsh environmental conditions. Fish inhabiting such systems must be biologically and ecologically adapted to surviving such conditions. Important environmental factors that Arctic fish must contend with include reduced light, seasonal darkness, ice cover, low biodiversity, and low seasonal productivity. No ESA-listed fish species occur within the Study Area. Fish present on the continental shelf are not analyzed herein, as they would not be impacted by aircraft flyovers.

3.2.3.1 Major Fish Groups

Marine fish can be broadly categorized into horizontal and vertical distributions within the water column. The primary distributions of fish that occur in the marine environment of the Study Area are within the water column near the surface. While there are multiple major fish groups inhabiting the deep waters of the Beaufort Sea (Table 3-3), the only federally managed species within the Study Area is the Arctic cod (*Arctogadus glacialis*) (Section 3.2.4.1.a).

Table 3-3. Major Groups of Marine Fish in the Study Area during the Proposed Action*

Common Name	***Scientific Name***	***Vertical Distribution Within the Study Area***
Cod	Order Gadiformes	Water column
Scorpionfish	Order Scorpaeniformes	Seafloor, water column
Eelpouts, Eelblennys, and Wolffishes	Order Perciformes	Seafloor

* All distribution information was obtained from Food and Agriculture Organization of the United Nations (Cohen et al. 1990), Kaschner et al. (2013), and Arctic Ocean Diversity (Mecklenburg and Mecklenburg 2009).

3.2.3.2 Hearing

All fish have two sensory systems to detect sound in the water: the inner ear, which functions very much like the inner ear in other vertebrates, and the lateral line, which consists of a series of receptors along the fish's body (Popper and Fay 2010a; Popper et al. 2014). The inner ear generally detects relatively higher-frequency sounds, while the lateral line detects water motion at low frequencies (below a few hundred Hz) (Hastings and Popper 2005). Although hearing capability data only exist for fewer than 100 of the 32,000 fish species, current data suggest that most species of fish detect sounds from 50 to 1,000 Hz, with a few fish hearing sounds above 4 kHz (Popper 2008). It is believed that most fish have their best hearing sensitivity from 100 to 400 Hz (Popper 2003b).

The inner ears of fish are directly sensitive to acoustic particle motion rather than acoustic pressure. Although a propagating sound wave contains pressure and particle motion components, particle motion is most significant at low frequencies (less than a few hundred Hz) and closer to the sound source (Popper and Fay 2010a). A fish's gas-filled swim bladder can enhance sound detection by converting acoustic pressure into localized particle motion, which may then be detected by the inner ear. Fish with swim bladders generally have better sensitivity and better high-frequency hearing than fish without swim bladders (Popper and Fay 2010b).

While no auditory studies have been completed on Arctic cod specifically, and anatomical differences may result in different hearing abilities, other Gadidae have the potential to be surrogate species for Arctic cod. Gadidae have been shown to detect sounds up to about 500 Hz (Popper 2008; Sand and Karlsen 1986). Atlantic cod (*Gadus morhua*) may also detect high-frequency sounds (Astrup and Mohl 1993). Astrup and Møhl (1993) indicated that conditioned Atlantic cod have high frequency thresholds of up to 38 kHz at 185 to 200 decibels referenced to 1 micropascal (dB re 1 µPa), which likely only allows for detection of predators at distances no greater than 10–30 m (Astrup 1999). A more recent study by Schack et al (2008) revisited the conclusions from Astrup and Mohl's study, arguing that hearing and behavioral responses in Atlantic cod would be different with unconditioned fish. They found that ultrasound exposures mimicking those of echosounders and odontocetes would not induce acute stress responses in Atlantic cod, and that frequent encounters with ultrasound sources would therefore most likely not induce a chronic state of stress (Schack et al. 2008). The discrepancies between the two studies remain unresolved, but it has been suggested the cod in Astrup and Mohl's (1993) study were conditioned to artifacts rather than to the ultrasonic component of the exposure (Astrup 1999; Ladich and Popper 2004; Schack et al. 2008). Additionally, Jørgensen et al (2005) found that juvenile Atlantic cod did not show any clear behavioral response when exposed to either 1.5 or 4 kHz simulated sonar sound. Therefore, accepted research on cod hearing indicates sensitivities limited to low-frequency sounds.

3.2.4 Essential Fish Habitat

The fisheries of the United States are managed within a framework of overlapping international, federal, state, interstate, and tribal authorities. Individual states and territories generally have jurisdiction over fisheries in marine waters within 3 nm of their coast. Federal jurisdiction includes fisheries in marine waters inside the U.S. Exclusive Economic Zone (EEZ), which encompasses the area from the outer boundary of state waters out to 200 nm offshore of any U.S.

coastline, except where intersected closer than 200 nm by bordering countries (61 FR 19390-19429, May 1, 1996). The Ice Camp Study Area resides within the U.S. EEZ, but outside of state jurisdiction.

The Ice Camp Study Area is within the jurisdiction of the North Pacific Fishery Management Council, which is responsible for designating Essential Fish Habitat and habitat areas of particular concern for all federally managed species occurring off the coast of Alaska. This Council has prepared and implemented a Fishery Management Plan for the Arctic Management Area, which encompasses all marine waters in the U.S. exclusive economic zone from 3 nm offshore of the Alaskan coast to 200 nm offshore north of the Bering Strait. This Fishery Management Plan identifies Essential Fish Habitat for Arctic cod, saffron cod (*Eleginus gracilis*), and snow crab (*Chionoecetes opilio*). Only Essential Fish Habitat for Arctic cod overlaps the Study Area (Figure 3-3). No habitat areas of particular concern have been designated for any species within the Arctic Management Area Fisheries Management Plan (North Pacific Fishery Management Council 2009).

The North Pacific Fishery Management Council has not delineated Essential Fish Habitat for eggs, larvae, and early juveniles of Arctic cod due to insufficient information. Essential Fish Habitat for late juvenile and adult Arctic cod within the Arctic Management Area occurs in waters from the nearshore to offshore areas along the continental shelf (0-200 m) and upper slope (200-500 m) throughout Arctic waters and often associated with ice floes which may occur in deeper waters (North Pacific Fishery Management Council 2009).

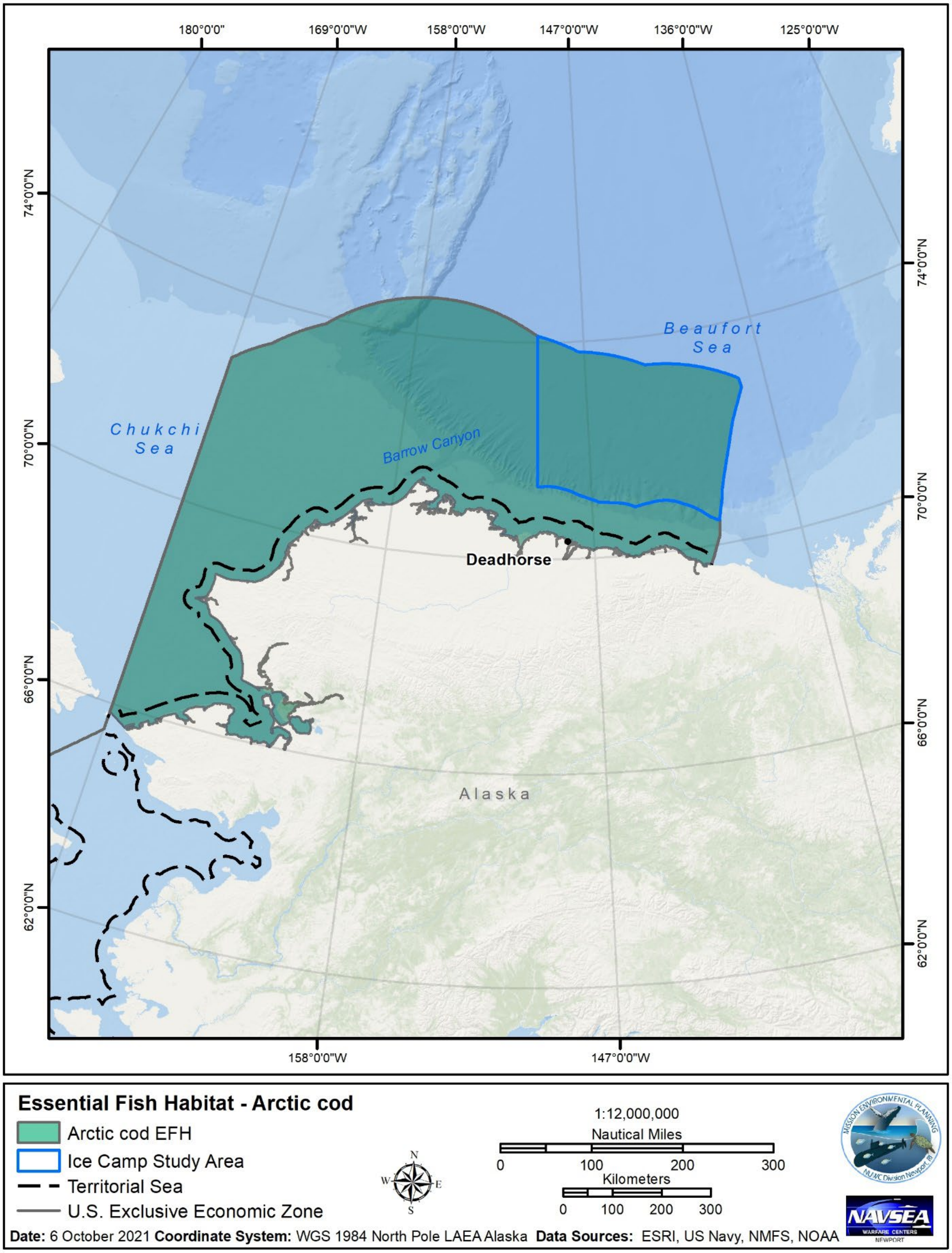


Figure 3-3. Essential Fish Habitat for Arctic Cod

3.2.5 Mammals

Both marine and terrestrial mammals may be present in the Study Area during the Proposed Action. Marine mammals are found throughout the Study Area including on the sea ice and within the water column. All marine mammals are protected under the MMPA, and some mammals, because they are threatened or endangered, are further protected by the ESA. Table 3-4 lists the mammals, and stock designation, if applicable, that may be within the Study Area during the Proposed Action. Other species, such as bowhead and beluga whales (*Balaena mysticetus* and *Delphinapterus leucas*, respectively), and narwhals (*Monodon monoceros*), may inhabit the Study Area during other times of the year (Burns et al. 1981; Garland et al. 2015; Heide-Jørgensen 2009; Jefferson et al. 2008; Muto et al. 2016) but are not expected in the area during the Proposed Action. Details about the geographic range, habitat and distribution, hearing, and predator/prey interactions of each species expected to be present in the Study Area during the Proposed Action are provided below.

Table 3-4. Mammals Found in the Study Area during the Proposed Action

Common Name	Scientific Name	Stock(s) within the Study Area	Critical Habitat within the Study Area
Marine Mammals			
Bearded seal[1]	*Erignathus barbatus nauticus*[2]	Beringia[3]	Proposed
Ringed seal[1]	*Phoca hispida*	Arctic/Bering Sea[3]	Proposed
Polar bear[1]	*Ursus maritimus*	Southern Beaufort Sea, Chukchi/Bering Sea	Not within the Study Area
Terrestrial Mammals			
Arctic Fox	*Vulpes lagopus*	n/a	n/a

[1] Species currently listed as threatened under the ESA.
[2] Scientific name of subspecies within the Study Area
[3] Stock is designated by the MMPA.

3.2.5.1 Bearded Seal

The bearded seal (*Erignathus barbatus*) is listed as threatened under the ESA, and listed as depleted under the MMPA. The bearded seal has been separated into two subspecies: *E. b. barbatus* and *E. b. nauticus*. Only the *E. b. nauticus* subspecies is located within the Study Area. Based on evidence, the *E. b. nauticus* subspecies was further divided into an Okhotsk Distinct Population Segment (DPS) and a Beringia DPS. The Beringia DPS is the only DPS of bearded seal that is located along the Beaufort Sea continental shelf within the Study Area (Muto et al. 2021). NMFS published a final rule (77 FR 76740; December 28, 2012) listing the Beringia and Okhotsk DPSs as threatened. No critical habitat is currently designated for the bearded seal. Critical habitat has been proposed for designation for the bearded seal (50 CFR 223); this critical habitat does not overlap with the ice camp study area (Figure 3-4).

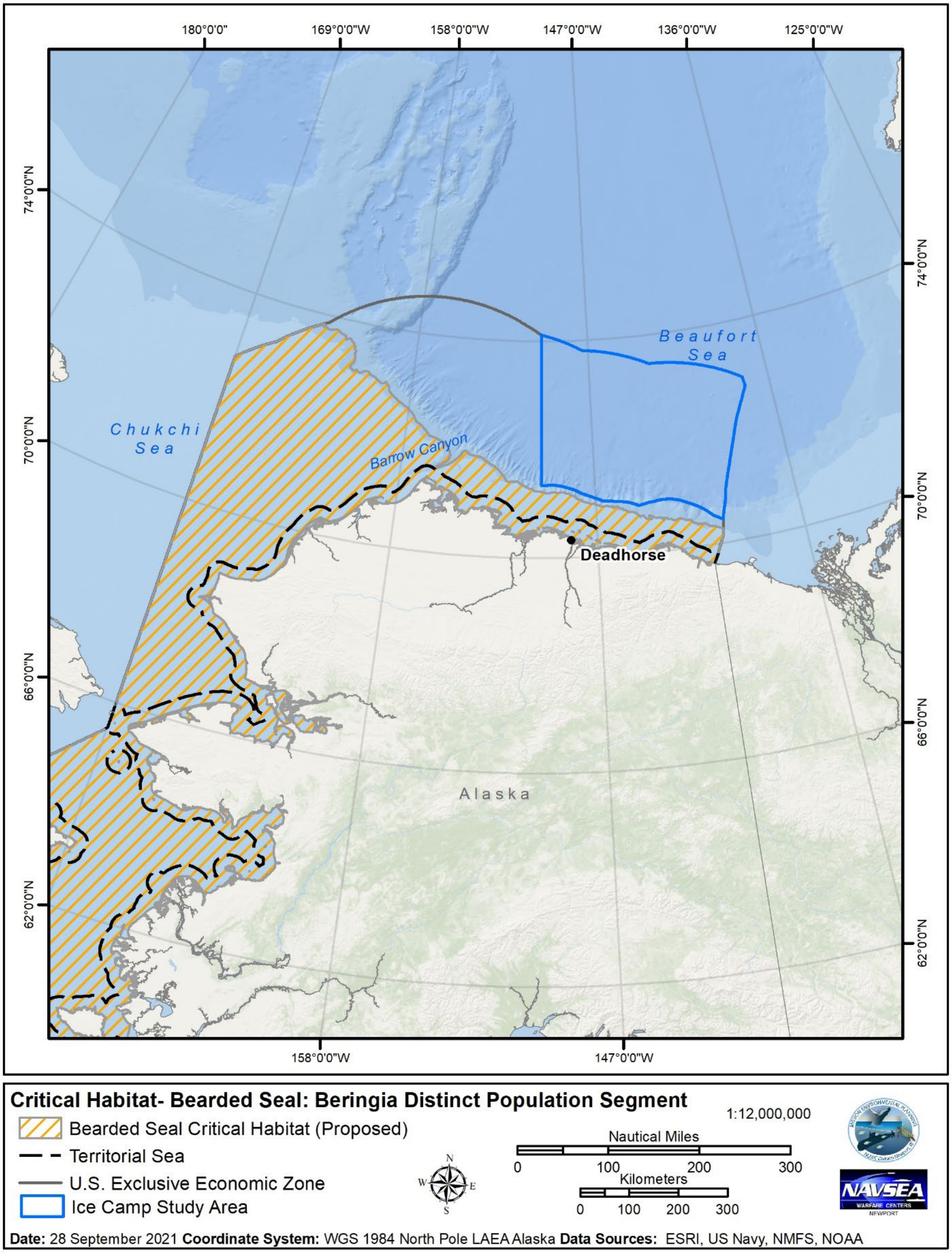


Figure 3-4. Proposed Critical Habitat for Bearded Seals

Bearded seals are found in the Northern Hemisphere with a circumpolar distribution that does not extend farther north than 85° N (Muto et al. 2016; Reeves et al. 2002). Beringia bearded seals are widely distributed throughout the northern Bering, Chukchi, and Beaufort Seas and are most abundant north of the ice edge zone (MacIntyre et al. 2013). Telemetry data from Boveng and Cameron (2013) showed that large numbers of bearded seals move south in fall/winter as sea ice forms and move north as the seasonal sea ice melts in the spring. The highest densities of bearded seals are found in the central and northern Bering Sea shelf during winter (Braham et al. 1981; Burns 1981; Burns and Frost 1979; Fay 1974; Heptner et al. 1976; Nelson et al. 1984). In late winter and early spring bearded seals are widely (not uniformly) ranging from the Chukchi Sea south to the ice front in the Bering Sea usually on drifting pack ice (Muto et al. 2021). In a shallow water study by MacIntyre et al. (2013), bearded seal calls were recorded throughout the year (11 to 12 months) in the Beaufort Sea, with the peak of calls detected from January to July. Bearded seals inhabit the seasonally ice-covered seas of the Northern Hemisphere, where they whelp and rear their pups, and molt their coats on the ice in the spring and early summer.

Bearded seals along the Alaskan coast tend to prefer areas where sea ice covers 70 to 90 percent of the surface, and are most abundant 20 to 100 nm offshore during the spring season (Bengston et al. 2000; Bengtson et al. 2005; Simpkins et al. 2003). In spring, bearded seals may also concentrate in nearshore pack ice habitats, where females give birth on the most stable areas of ice (Reeves et al. 2002). Bearded seals haul out on spring pack ice (Simpkins et al. 2003) and generally prefer to be near polynyas (areas of open water surrounded by sea ice) and other natural openings in the sea ice for breathing, hauling out, and prey access (Nelson et al. 1984; Stirling 1997). While molting between April and August, bearded seals spend substantially more time hauled out than at other times of the year (Reeves et al. 2002). The farthest from shore that bearded seals were observed was the waters of the continental slope (within 50 nm from Prudhoe Bay).

Bearded seals feed on the seafloor, commonly occupying shallow waters (Fedoseev 2000; Kovacs 2002). The preferred depth range is often described as less than 200 m (Allen and Angliss 2014; Fedoseev 2000; Jefferson et al. 2008; Kovacs 2002), although adults have been known to dive to around 300 m (Cameron and Boveng 2009; Kovacs 2002). At these depths, they feed on demersal fish (e.g. Arctic and saffron cod, flatfish, and sculpins and a variety of small invertebrates that live in the substrate or on its surface (Fedoseev 2000; Kovacs 2002)). They may also opportunistically supplement their diet with crab, shrimp, mollusks, and octopus (Reeves et al. 2002).

Bearded seals may be present close to the continental shelf and therefore, may be present in the Study Area, though would most likely be encountered exclusively in proximity of Prudhoe Bay, Alaska.

3.2.5.2 Ringed Seal

The ringed seal, specifically the Arctic/Bering Sea subspecies *Phoca hispida hispida*, occurs within the U.S. EEZ of the Beaufort, Chukchi, and Bering Seas and overlaps with the Study Area (Kelly et al. 2009; Palo 2003; Palo et al. 2001). The ringed seal is listed as threatened under the ESA. In March 2016, the U.S. District Court for the District of Alaska in the case of Alaska Oil & Gas Association v. National Marine Fisheries Service, et al. (Case no:14-cv-00029-RRB) vacated the NMFS ESA listing of the Arctic/Bering Sea subspecies of ringed seals (*P. h. hispida*) as threatened under the ESA. On February 12, 2018, the U.S. Court of Appeals for the Ninth Circuit reversed the District Court's decision and upheld NMFS' listing of the Arctic/Bering Sea subspecies (Alaska Oil & Gas Ass'n v. Ross, 722 Fed. Appx. 666 9th Cir. Feb. 12, 2018). No critical habitat is currently designated. NMFS has announced revisions to previously proposed critical habitat for the ringed seal (79 FR 71714; December 3, 2014), which would fall within the Study Area and includes all the contiguous marine waters from the coast line of Alaska to an offshore limit of the U.S. EEZ north of Alaska (Figure 3-2). Based on consideration of national security impacts, the revised proposed critical habitat designation includes a proposal to exclude an area where Navy training and testing occurs (which includes the ice camp study area) from the designation. A public comment period was open through April 8, 2021, and final rule is anticipated for March 2022. The Arctic/Bering Sea subspecies is listed as depleted and strategic under the MMPA. For purposes of this analysis the Alaska stock of ringed seals, as designated under the MMPA, is the portion of the subspecies *P. h. hispida* population that occurs within the U.S. EEZ of the Beaufort, Chukchi, and Bering Seas.

NMFS and USFWS joint regulations (50 CFR § 424.12(b)) state that, in determining what areas qualify as critical habitat, the agencies "shall consider those physical and biological features that are essential to the conservation of a given species and that may require special management considerations or protection." These essential features "may include, but are not limited to, the following: spawning sites, feeding sites, seasonal wetland or dryland, water quality or quantity, geological formation, vegetation type, tide, and specific soil types." In a proposed rule on December 3, 2014, NMFS identified areas used by ringed seals along with a description of those features essential to conservation. These three features are as follows:

(1) Sea ice habitat suitable for the formation and maintenance of subnivean birth lairs used for sheltering pups during whelping and nursing.

(2) Sea ice habitat suitable as a platform for basking and molting, which is defined as sea ice of 15 percent or more concentration, except for bottom-fast ice extending seaward from the coastline in waters less than 2 m deep.

(3) Primary prey resources to support Arctic ringed seals, which are defined to be Arctic cod, saffron cod, shrimps, and amphipods.

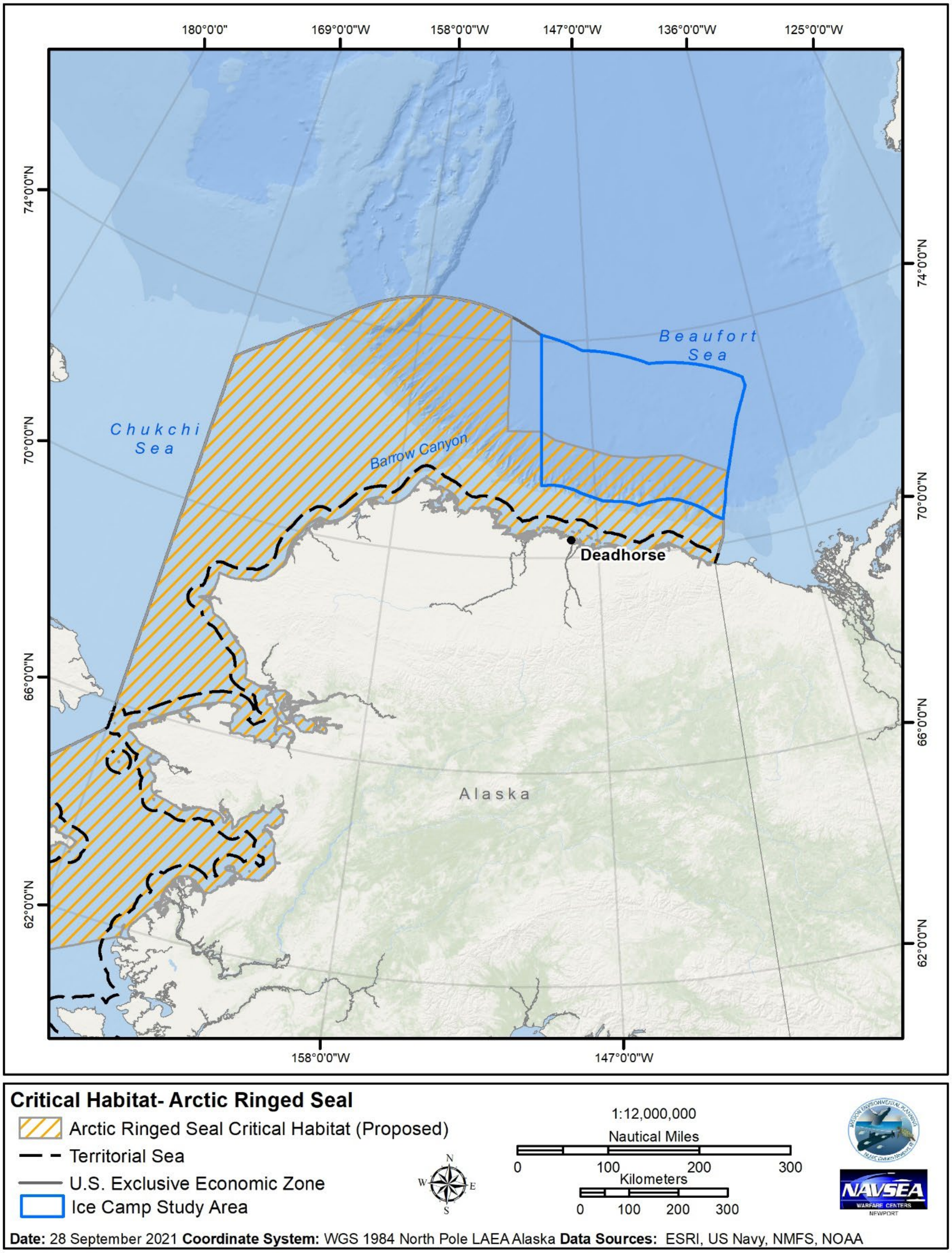


Figure 3-5. Ringed Seal Distribution in Study Area

NMFS determined that the essential features of the habitat of the Arctic ringed seal may require special management considerations or protection in the future to minimize the risks posed to these features by potential shipping and transportation activities. The reason for this was because: (1) both the physical disturbance and noise associated with these activities could displace seals from favored habitat that contains the essential features, thus altering the quantity and/or quality of these features; and (2) in the event of an oil spill, sea ice essential for birth lairs and for molting could become oiled, and the quantity and/or quality of the primary prey resources could be adversely affected.

Ringed seals are the most common pinniped in the Study Area and have wide distribution in seasonally and permanently ice-covered waters of the Northern Hemisphere (North Atlantic Marine Mammal Commission 2004). Throughout their range, ringed seals have an affinity for ice-covered waters and are well adapted to occupying both shore-fast and pack ice (Kelly 1988b). Ringed seals can be found further offshore than other pinnipeds since they can maintain breathing holes in ice thickness greater than 2 m (Smith and Stirling 1975). Breathing holes are maintained by ringed seals' sharp teeth and claws on their fore flippers. They remain in contact with ice most of the year and use it as a platform for molting in late spring to early summer, for pupping and nursing in late winter to early spring, and for resting at other times of the year. 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). Passive acoustic monitoring of ringed seals from a high frequency recording package deployed at a depth of 240 m in the Chukchi Sea 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).

Ringed seals have at least two distinct types of subnivean lairs: haulout lairs and birthing lairs (Smith and Stirling 1975). Haulout lairs are typically single-chambered and offer protection from predators and cold weather. Birthing lairs are larger, multi-chambered areas that are used for pupping in addition to protection from predators. Ringed seals pup on both land-fast ice as well as stable pack ice. Lentfer (1972) found that ringed seals north of Barrow, Alaska (west of the ice camp study area depicted in Figure 2-1), build their subnivean lairs on the pack ice near pressure ridges. Since subnivean lairs were found north of Barrow, Alaska, in pack ice, they are also assumed to be found within the sea ice in the ice camp proposed action area. Ringed seals excavate subnivean lairs in drifts over their breathing holes in the ice, in which they rest, give birth, and nurse their pups for 5–9 weeks during late winter and spring (Chapskii 1940; McLaren 1958; Smith and Stirling 1975). Snow depths of at least 50–65 cm are required for functional birth lairs (Kelly 1988a; Lydersen 1998; Lydersen and Gjertz 1986; Smith and Stirling 1975), and such depths typically are found only where 20–30 cm or more of snow has accumulated on flat ice and then drifted along pressure ridges or ice hummocks (Hammill 2008; Lydersen et al. 1990; Lydersen and Ryg 1991; Smith and Lydersen 1991). Ringed seals are born beginning in March, but the majority of births occur in early April. About a month after parturition, mating begins in late April and early May.

In general, ringed seals prey upon fish and crustaceans. Ringed seals are known to consume up to 72 different species in their diet; their preferred prey species is the polar cod (Jefferson et al. 2008). Ringed seals also prey upon a variety of other members of the cod family, including Arctic cod (Holst et al. 2001), and saffron cod, with the latter being particularly important during the summer months in Alaskan waters (Lowry et al. 1980). Invertebrate prey seems to become prevalent in the ringed seals diet during the open-water season and often dominates the diet of young animals (Holst et al. 2001; Lowry et al. 1980). Large amphipods (e.g., *Themisto libellula*), krill (e.g., *Thysanoessa inermis*), mysids (e.g., *Mysis oculata*), shrimps (e.g., *Pandalus* spp., *Eualus* spp., *Lebbeus polaris*, and *Crangon septemspinosa*), and cephalopods (e.g., *Gonatus* spp.) are also consumed by ringed seals.

3.2.5.3 Polar Bear

Two polar bear stocks occur within the Study Area: (1) the Southern Beaufort Sea stock and (2) the Chukchi/Bering Seas stock. Both of these stocks are listed as threatened under the ESA (73 FR 28212, May 15, 2009). The determination of polar bears as threatened under the ESA was made based on an extinction risk assessment. This assessment found that the main concern regarding the conservation of polar bears stems from the loss of habitat, particularly sea ice. Polar bears were determined to likely become endangered within the foreseeable future (defined as 45 years) throughout its range, based on expected continued decline of sea ice. Additionally, both stocks are currently listed as depleted and classified as strategic under the MMPA. In 2010, USFWS designated 484,734 km^2 of on-shore and off-shore critical habitat for polar bears. Polar bear critical habitat extends out from the shoreline into the Study Area, however is not present within the ice camp proposed action area.

The Chukchi/Bering Seas stock is widely distributed on the pack ice in the Chukchi Sea and northern Bering Sea and adjacent coastal areas in Alaska and Russia. An extensive area of overlap between the Southern Beaufort Sea stock and the Chukchi/Bering Seas stock occurs between Point Barrow and Point Hope, centered near Point Lay (Amstrup 2000; Garner et al. 1994; Garner et al. 1990).

The Southern Beaufort Sea population spends the summer on pack ice and moves toward the coast during fall, winter, and spring (Durner et al. 2004). Polar bears in the Southern Beaufort Sea concentrate in waters less than 300 m deep over the continental shelf and in areas with greater than 50 percent ice cover in all seasons except summer to access prey such as ringed and bearded seals (Durner et al. 2004; Durner et al. 2006; Durner et al. 2009; Stirling et al. 1999). The eastern boundary of the Southern Beaufort Sea stock occurs south of Banks Island and east of the Baillie Islands, Canada (Amstrup et al. 2000). The western boundary of the Southern Beaufort Sea stock is near Point Hope, Alaska. Polar bears from this population have historically denned on both the sea ice and land. Therefore, the southern boundary of the Southern Beaufort Sea stock is defined by the limits of terrestrial denning sites inland of the coast, which follows the shoreline along the North Slope in Alaska and Canadian Arctic (Bethke et al. 1996). Polar bears could be within the Study Area at any time during the Proposed Action. General year-round distribution of polar bears within the Study Area is depicted in Figure 3-6.

Mating occurs in late March through early May, which overlaps with the timeframe of the Proposed Action. In November and December, females dig maternity dens in pressure ridges in fast ice, drifting pack ice, or on land (up to 161 km inland). Females give birth to their cubs from December to January and stay within their dens until spring (Reeves et al. 2002).

Each year, only 25 percent of reproductively active females produce a litter. Studies conducted between 1981 and 1994 of radio-collared bears found over half of the dens on sea ice (53 percent on pack ice and 4 percent on land fast ice) with the remainder of dens on land. Polar bears do not show fidelity to specific den sites but certain bears do show fidelity to denning on either land or sea ice. Denning sites in the Beaufort Sea and neighboring regions of Alaska are depicted in Figure 3-6.

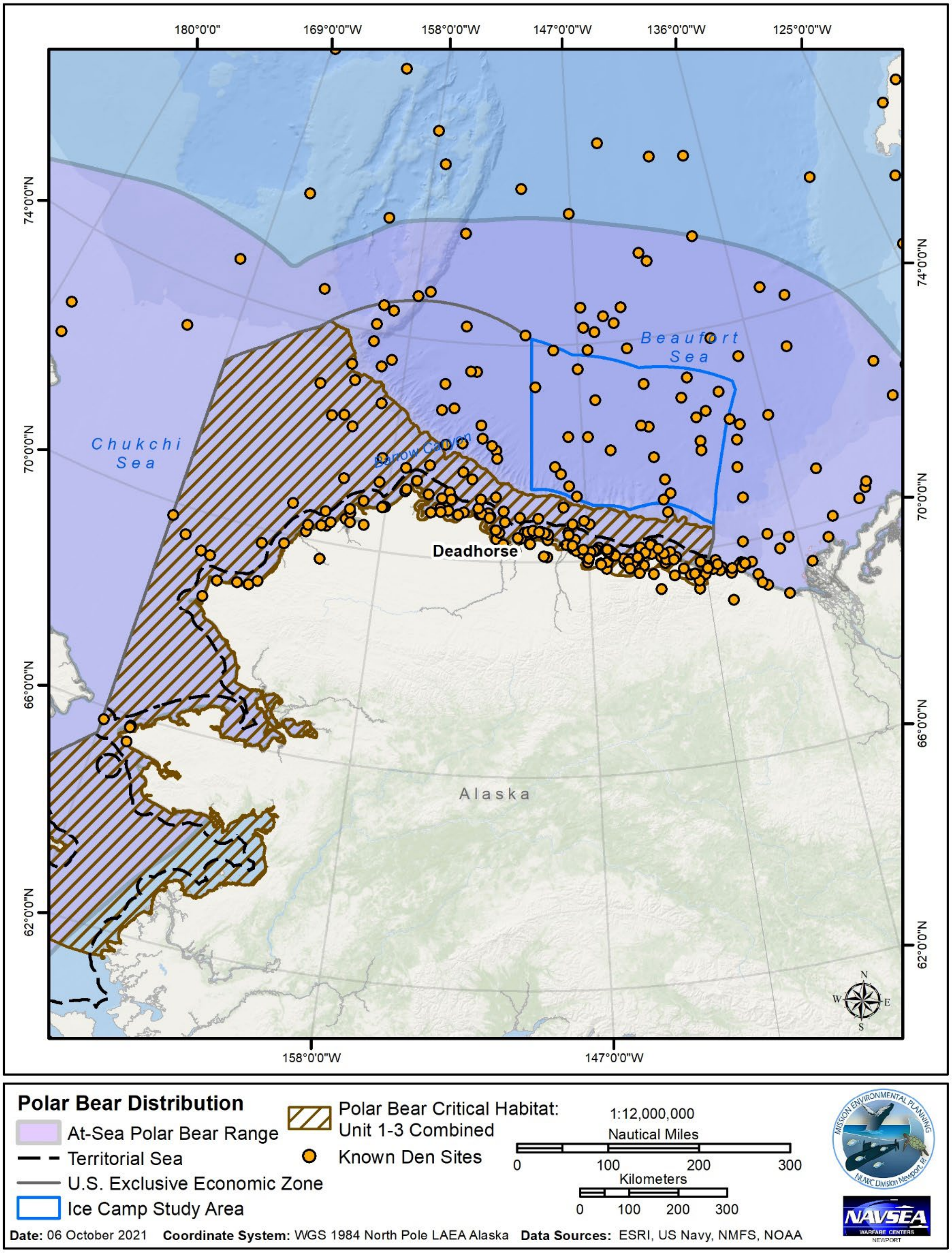


Figure 3-6. Polar Bear At-Sea Distribution in Study Area

Polar bears' main prey are ringed and bearded seals (Durner et al. 2004; Durner et al. 2006; Durner et al. 2009; Stirling et al. 1999). Occasionally, polar bears are known to prey upon walruses or beluga whales trapped by ice, and may also consume carrion when prey is scarce (U.S. Fish and Wildlife Service 2014).

3.2.5.4 Arctic Fox

The Arctic fox is not listed as threatened or endangered under the ESA. The Arctic fox has a circumpolar distribution in all Arctic tundra habitats. Their preferred habitat is tundra, near rocky shores. In general, the Arctic fox inhabits Eurasia, North America, Greenland, and the Canadian archipelago. More specifically, their distribution includes most Arctic islands and many islands in the Bering Sea. Off the coast of Alaska, Arctic foxes can be found in both the Beaufort and Chukchi Seas.

Eberhardt and Hansson (1978) discovered that Arctic foxes are capable of long migrations (greater than 1,000 km) over the polar pack ice. In a study by Pamperin (2008), collared Arctic foxes travelled between 904 and 2,757 km during the winter season averaging 8 to 18 km per day with the longest travel distance of 38 mi (61 km) in one day. Migrations seaward occur in the fall and early winter seasons and migrations back to shore occur in the late winter and early spring. They have been observed ranging far out into the pack ice during the winter with observations as far north as the North Pole. The Arctic fox could be found in the Study Area at any time during the Proposed Action.

Breeding occurs north of and above the tree line on the Arctic tundra in North America and Eurasia and on the alpine tundra in Fennoscandia, ranging from northern Greenland at 88° N to the southern tip of Hudson Bay, Canada, at 53° N. Mating for Arctic foxes occurs in March and early April with a gestation period of 52 days. Mothers give birth to litters averaging between seven and 15 pups. The worldwide population of Arctic foxes is several thousand animals.

Generally two ecotypes of Arctic foxes are recognized: (1) lemming foxes and (2) coastal foxes. Lemming foxes prey mainly on lemmings (*Lemmus* spp. and *Dicrostonyx* spp.) (Dalén 2005), while the coastal foxes' diet consists of eggs, birds, and scavenged remains of other animals (Braestrup 1941). Some populations of foxes will switch between lemmings, migratory birds, fish, and marine invertebrates depending on prey availability (Angerbjörn and Tannerfeldt 2014).

When Arctic foxes are roaming the sea ice in winter, they scavenge on seals killed by polar bears (Andriashek et al. 1985; Roth 2002; Tarroux et al. 2010). During spring, Arctic foxes also invade the subnivean lairs of ringed seals to prey on their pups (Lydersen and Hammill 1993; Smith 1976; Smith and Lydersen 1991). When travelling, Arctic foxes are usually found in breeding pairs, though the species typically hunts alone (Angerbjörn and Tannerfeldt 2014).

3.2.5.5 Hearing

All marine mammals that have been studied can use sound to forage, orient, socially interact with others, and detect and respond to predators. Measurements of marine mammal sound production and hearing capabilities provide some basis for assessment of whether exposure to a particular sound source may affect a marine mammal behaviorally or physiologically.

Ringed and bearded seals fall into the phocid seal hearing group. Functional hearing limits for this hearing group are estimated to be 75 Hz–30 kHz in air and 75 Hz–75 kHz in water (Kastak and Schusterman 1999; Kastelein et al. 2009a; Kastelein et al. 2009b; Møhl 1968a, 1968b; Reichmuth 2008; Terhune and Ronald 1971, 1972). No studies have directly measured bearded seal hearing. Cleator et al (1989) recorded bearded seal calls at six sites in the Arctic. Calls ranged in frequency from 130 Hz to 10.5 kHz. Although, hearing sensitivities for bearded seals have not been directly measured it is assumed best sensitivities would be at the same frequencies as their calls. Phocids can make calls between 90 Hz and 16 kHz (Richardson et al. 1995). The generalized hearing for phocids (underwater) (National Marine Fisheries Service 2016) ranges from 50 Hz to 86 kHz, which includes the suggested auditory bandwidth for pinnipeds in water proposed by Southall et al. (2007), ranging between 75Hz to 75 kHz. Based on a study by Sills *et al.* (2015), the best frequencies for ringed seal hearing were 12.8 and 25.6 kHz at 49 and 50 decibels referenced to 1 microPascal at 1 meter (dB re 1µPa) respectively. The best hearing range for ringed seals combined was 0.4 to 52 kHz (Sills et al. 2015). Data on ringed seal hearing indicates an upper frequency limit to be 60 kHz (Terhune and Ronald 1976), which falls within the phocid hearing group.

Airborne hearing threshold measurements of polar bears have shown best hearing sensitivity between 8 and 14 kHz, with a rapid decline in sensitivity below 125 Hz and above 20 kHz (Bowles et al. 2008; Nachtigall et al. 2007; Owen and Bowles 2011). Like the pinnipeds, polar bears are amphibious mammals in the order Carnivora. Additionally, the polar bear ear is very similar to the otariid ear and therefore the polar bear is placed within the same hearing group as otariids (Nummela 2008a; Nummela 2008b). Hearing limits for this group are 50 Hz–35 kHz in air and 50 Hz–50 kHz in water (Southall et al. 2007).

Little research has been conducted into the hearing thresholds of Arctic foxes. Stansbury et al (2014) studied the behavioral responses of two captive Arctic foxes exposed to sound signals; the foxes had a functional hearing range of 125 Hz to 16 kHz (sensitivity up to 60 dB re 20 µPa), and an average peak sensitivity of 24 dB re 20 µPa at 4 kHz. This study concluded that Arctic foxes may have a lower frequency range than other domestic dogs and carnivores, though differences could be due to testing constraints (Stansbury et al. 2014). Malkemper et al (2015) were able to create an audiogram of the red fox (within the same family as the arctic fox). In this study it was found that red foxes have a low frequency hearing limit at 51 Hz and a high frequency hearing limit at 48 kHz, with maximum sensitivity at 4 kHz. Best sensitivity for the red fox is the same as the arctic fox (Malkemper et al. 2015; Stansbury et al. 2014). The high frequency cut-off for the red fox is comparable to the domestic dog while the low frequency cut-off is comparable to the domestic cat.

3.3 SOCIOECONOMIC ENVIRONMENT

3.3.1 Subsistence Hunting

Subsistence hunting is defined as the customary and traditional uses of wild resources for food, clothing, fuel, transportation, construction, art, crafts, sharing, and customary trade. Subsistence hunting and fishing is important for many of the Alaska Native communities. Subsistence uses are central to the traditions and customs of many cultural groups in Alaska. The subsistence food harvest by Alaska residents represents only 0.9 percent of the fish and game harvested annually in Alaska. In Prudhoe Bay, which is considered an urban area (under federal rules), residents only harvested 35 pounds of wild food per person, compared to the rural arctic area where the residents harvested 370 pounds of wild food per person (Alaska Department of Fish and Game 2014). Subsistence hunting is year-round in Alaska. During the timeframe of the Proposed Action subsistence hunting is limited to furbearers and caribou, with some harvests of fish, especially burbot. Spring hunting consists mainly of geese, but also includes bowhead whales in Barrow. Bowhead whale hunting does not start until April. Although there may be some potential overlap in the timeframe (April) of the Proposed Action; bowhead whale hunting would occur in open leads in the Chukchi Sea during the month of April, which is outside of the Study Area (Stephen R. Braund & Associates 2010).

The North Slope villages of Nuiqsut, Kaktovik, and Barrow identifies the primary resources used for subsistence and the locations for harvest (Stephen R. Braund & Associates 2010), including terrestrial mammals (caribou, moose, wolf, and wolverine), birds (geese and eider), fish (Arctic cisco, Arctic char/Dolly Varden trout, and broad whitefish), and marine mammals (bowhead whale, ringed seal, bearded seal, and walrus). The geographic extent of the harvest for all species identified in Stephen R. Braund & Associates (2010) is provided in Figure 3-7. Of the species reported, ringed seals could be located within the ice camp study area during the Proposed Action. Bearded seals may be near Prudhoe Bay during the Proposed Action.

Bearded seals are an important subsistence resource for residents in the north slope of Alaska. They are the primary marine mammal (other than bowhead whales) hunted in the area. Bearded seal hunting in Kaktovik is more common than ringed seal hunting. Bearded seal meat and oil are used for consumption, and hides are also used in building skin boats which are used during the spring whaling season (Ice Seal Committee 2014; Stephen R. Braund & Associates 2010). Peak hunting season for bearded seal starts in June and goes into September. Bearded seal hunts follow the ice pack although hunters tend to stay closer to shore due to safety concerns, but some hunters will travel up to 65 km from shore in pursuit of the bearded seals (Stephen R. Braund & Associates 2010). To estimate the recent harvest of ice seals, Nelson et al. (2019) used ice seal harvest survey data collected from 1992 to 2014 for 41 of 55 communities that regularly hunt ice seals, as well as the per capita removal estimates based on the 2015 population from the surveyed communities, to estimate the average regional and statewide subsistence harvest. The average regional subsistence harvest of Beringia bearded seals during that period for the North Slope Borough is 1,031 animals (Nelson et al. 2019).

Ringed seals are of lesser importance to many North Slope communities, and have historically been used as a primary source of food for dog teams; this need has lessened with the introduction of snowmobiles. Ringed seal meat is used to supplement bearded seal and other meat. Ringed seal hunting typically occurs during the summer months, though hunting has occurred year-round. Harvest locations for ringed seals during winter typically occurs within several miles of shore (Stephen R. Braund & Associates 2010). From 1985 through 2003, for years in which data were available, an average of 419 ringed seals were harvested per year for the villages of Barrow, Nuiqsut, and Kaktovik (Stephen R. Braund & Associates 2010). With the addition of the North Slope villages of Wainright, Point Lay, and Point Hope, an average of 1,099 ringed seals were harvested per year (Ice Seal Committee 2014). Based on estimates by Nelson et al. (2019), average regional subsistence harvest for the North Slope Borough is 1,146 ringed seals. The number of seals harvested in a given year can vary considerably, depending upon environmental (e.g., ice) conditions.

In addition to ringed and bearded seals, polar bears and Arctic foxes are also hunted for subsistence. Polar bears have historically been killed for subsistence, handicrafts, and recreation (sport hunting was banned in 1972 with the passing of the MMPA). From 2003 to 2007, the average annual harvest of polar bears was 70 (33 from the Southern Beaufort Stock and 37 from the Chukchi/Bering Seas Stock) (Allen and Angliss 2011). Bacon et al. (2011) identify that polar bears are harvested year-round, though many communities do not typically harvest this species.

Arctic foxes are harvested as one of many furbearers used by Alaska Natives. Hunting of Arctic fox generally occurs from October through April, based on subsistence data collected from seven North Slope villages (Anaktuvuk Pass, Atqasuk, Barrow, Kaktovik, Nuiqsut, Point Hope, Point Lay, and Wainwright) from 1994 through 2003 (Bacon et al. 2011). For some villages, only a single year of survey data was collected; other villages had multiple years of survey data. After averaging data for each village (where multiple years were provided) and combining each average, an estimated 164 Arctic foxes are harvested per year. However, data between years can vary greatly. For example, the estimated total harvest (based on the reported number plus a statistical estimate for houses not surveyed) for Arctic fox in Barrow during calendar year 2000 was 90.8 foxes, whereas the calendar year 2001 harvest was only 1.7 (Bacon et al. 2011). Arctic foxes are under no direct management, and are open to trapping and sport hunting.

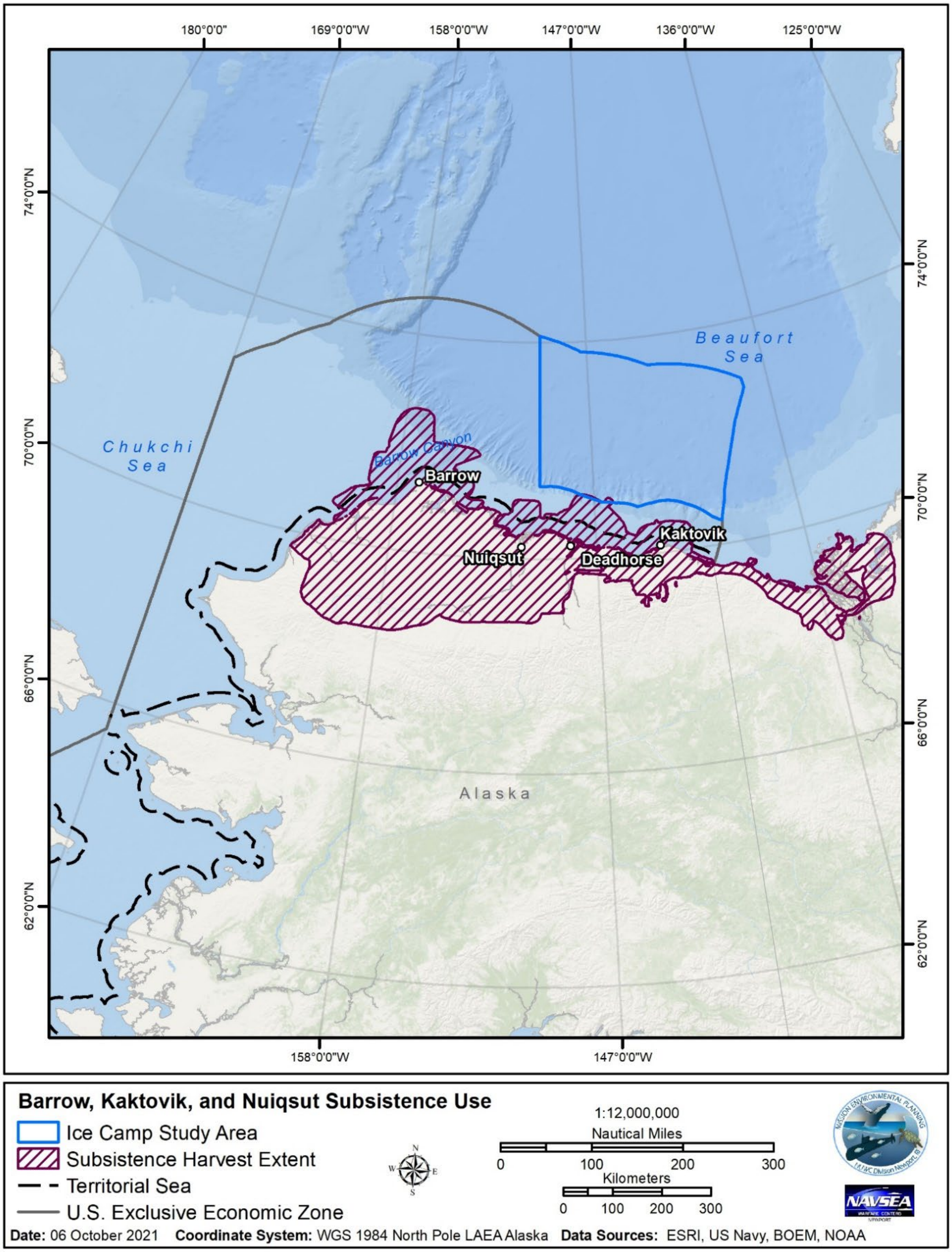


Figure 3-7. Subsistence Harvest Extent for Villages of Barrow, Kaktovik, and Nuiqsut

CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

This chapter discusses the potential environmental consequences of the Proposed Action to the natural and physical environments described in Chapter 3. Stressors resulting from the Proposed Action that may potentially impact or harm the biological or physical environment include:

- Acoustic: acoustic transmissions, aircraft noise, on-ice vehicle noise
- Physical: aircraft strike, on-ice vehicle strike, in-water vessel and vehicle strike, human presence
- Expended Material: combustible byproducts, bottom disturbance, entanglement, ingestion

The Proposed Action would not impact air quality within the Study Area during the timeframe of the Proposed Action. The addition of flight traffic into and out of the Deadhorse Airport, in Prudhoe Bay, would not be substantial enough to have a significant impact on overall emissions levels within the region. Any other emissions, created by generators or aircraft near the ice camp study area, would be outside of any attainment areas or Clean Air Act jurisdiction. Therefore, no further analysis of air quality effects will be presented.

The Proposed Action would not impact subsistence hunting as hunting for bearded and ringed seals does not occur within the Study Area during the timeframe of the Proposed Action. While aircraft may fly over a subsistence hunting area near the coast, it would be within the flight corridors already used by aircraft from Deadhorse Airport. Any potential impact to a bearded or ringed seal from aircraft overflights within a subsistence hunting area would be temporary and minor. Otherwise all other activities associated with the Proposed Action would be outside of known subsistence hunting areas. Although hunting for polar bears and arctic foxes does occur year-round, the Proposed Action is far outside of the normal areas hunting occurs, including the Deadhorse Beta camp study area. Therefore, no further analysis of socioeconomic effects will be presented.

Under the No Action Alternative, the Proposed Action would not occur; therefore, there would be no impact or harm to the natural and physical environments. No further analysis of the No Action Alternative will be presented. Appendix E provides a description of each stressor, as well as matrices showing which activities generate each stressor and what resources are impacted by each stressor.

4.1 ACOUSTIC STRESSORS

The acoustic stressors from the Proposed Action include active acoustics, aircraft noise, and on-ice vehicle noise. Acoustic transmissions would only occur during ICEX events and not during Beta camps.

4.1.1 Acoustic Transmissions

Both submarine training and research activities have acoustic transmissions that require quantitative analysis, these activities would only occur biennially and would not occur during the

Beta camp. Some acoustic sources are either above the known hearing range of marine species or have narrow beam widths and short pulse lengths that would not result in effects to marine species. Potential effects from these "*de minimis*" sources are analyzed qualitatively in accordance with current Navy policy. Navy acoustic sources are categorized into "bins" based on frequency, source level, and mode of usage, as previously established between the Navy and NMFS (Department of the Navy 2013a). The acoustic transmissions associated with submarine training fall within bins HF1 (hull-mounted submarine sonars that produce high-frequency [greater than 10 kHz but less than 200 kHz] signals), MF3 (hull-mounted submarine sonars that produce mid-frequency [1-10 kHz] signals), M3 (mid-frequency acoustic modems greater than 190 dB re 1 µPa), and TORP2 (heavyweight torpedo). The parameters for the acoustic transmissions associated with unclassified research activities can be found in Table 2-2 above. All submarine training events would occur over an approximately four-week timeframe. Although details about submarine training events are classified, the analysis below includes both submarine training and research activities. Details on submarine training events can be found in the classified Appendix D.

In assessing the potential for impacts to biological resources from acoustic transmissions, a variety of factors must be considered, including source characteristics, animal presence and associated density, duration of exposure, and thresholds for injury and harassment for the species that may occur in the Study Area. The types of potential consequences to biological resources from acoustic sources can be grouped in the following categories:

Non-auditory injury: Non-auditory injury can occur to lungs and organs and can cause tissue damage. Resonance occurs when the frequency of the sound waves matches the frequency of vibration of the air filled organ or cavity, causing it to resonate. This can, in certain circumstances, lead to damage to the tissue making up the organ or air filled cavity. Tissue damage can also be inflicted directly by sound waves in cases of sound waves with high amplitude and rapid rise time.

Auditory injury: A potentially severe condition that occurs when sound intensity is very high or of such long duration that the result is a Permanent Threshold Shift (PTS) or permanent hearing loss on the part of the listener. The intensity and duration of a sound that will cause PTS varies across species and even between individual animals. PTS is a consequence of the death of sensory hair cells of the auditory epithelia of the ear and a resultant loss of hearing ability in the general vicinity of the frequencies of stimulation (Myrberg 1990; Richardson et al. 1995).

Physiological disruption: Sounds of sufficient loudness can cause a temporary condition impairing an animal's hearing for a period of time, called a Temporary Threshold Shift (TTS). After termination of the sound, it is characterized by a normal hearing ability returning over a period of time that may range anywhere from minutes to days, depending on many factors including the intensity and duration of exposure to the intense sound. The precise physiological mechanism for TTS is not well understood. It may result from fatigue of the sensory hair cells as a result of over-stimulation, or from some small damage to the cells that are repaired over time. Hair cells may be temporarily affected by exposure to the sound but they are not permanently damaged. Thus, TTS is not considered to be an injury (Richardson et al. 1995), although animals may be at some disadvantage in terms of detecting predators or prey in affected frequency bands while the TTS persists.

Behavioral disruption: Marine animals may exhibit short-term behavioral reactions such as cessation of feeding, resting, or social interaction, and may also exhibit alertness or avoidance behavior(Richardson et al. 1995).

Masking: The presence of intense sounds or sounds within a mammals hearing range in the environment potentially can interfere with an animal's ability to hear relevant sounds. This effect, known as "auditory masking," could interfere with the animal's ability to detect biologically relevant sounds such as those produced by predators or prey, thus increasing the likelihood of the animal not finding food or being preyed upon (Myrberg 1981; Popper et al. 2004). Masking only occurs in the frequency band of the sound that causes the masking condition. Other relevant sounds with frequencies outside of this band would not be masked.

The potential effects of acoustic transmissions on invertebrates, fish, and marine mammals are provided below. Given the ice cover during the timeframe of the Proposed Action, bird species are not expected to be within the water column or potentially exposed to acoustic transmissions. Therefore, the impacts of acoustic transmissions on birds are not further analyzed. Acoustic transmissions under Alternatives 1 and 2 would be the same, and would only occur in the ice camp study area.

4.1.1.1 Invertebrates

Hearing capabilities of invertebrates are largely unknown, although they are not expected to hear sources above 3 kHz (see section 3.2.1.1 for invertebrate hearing information). Invertebrates are only expected to potentially perceive the signals of a few sources used during the Proposed Action. In addition, most marine invertebrates in water are known to detect only particle motion associated with sound waves, which drop off rapidly with distance (Graduate School of Oceanography 2015).

Within the Study Area, marine invertebrate abundance is low within the sea ice and in the water column. The highest densities are on the seafloor, further reducing the likelihood of invertebrates hearing the frequencies of the active acoustic sources due to the dissipation of the acoustic transmission in the water column. As stated in Section 3.2.1.1, invertebrate hearing is largely unknown. In studies by Christian et al. (2003) and Payne et al. (2007), neither found damage to lobster or crab statocysts from high intensity air gun firings (which is of greater intensity than the acoustic transmissions of sound sources in the Proposed Action). Furthermore, in the study by Christian et al. (2003), no changes were found in biochemical stress markers in snow crabs.

Acoustic transmissions from both Alternatives 1 and 2 would result in the same potential for effects to invertebrates, in that the exposure to acoustic transmissions in the frequency range that may impact invertebrates would be the same for both alternatives. A low likelihood exists that invertebrates would be able to perceive the acoustic transmissions, and if perceived, that an individual animal would react.

4.1.1.2 Fish

As discussed in Section 3.2.3.2, data on hearing sensitivities of fish species occurring in the Study Area are not known. Research on fish hearing is limited; however, there is the potential for a fish with hearing sensitivities yet to be determined to perceive the sound of the Proposed

Action. PTS has not been documented in fish. A study regarding mid-frequency sonar exposure by Halvorsen et al. (2012) found that for temporary hearing loss or similar negative impacts to occur, the noise needed to be within the fish's individual hearing frequency range; external factors, such as developmental history of the fish or environmental factors, may result in differing impacts to sound exposure in fish of the same species. The sensory hair cells of the inner ear in fish can regenerate after they are damaged, unlike in mammals where sensory hair cell loss is permanent (Lombarte et al. 1993; Smith et al. 2006). As a consequence, any hearing loss in fish may be as temporary as the timeframe required to repair or replace the sensory cells that were damaged or destroyed (Smith et al. 2006), and no permanent loss of hearing in fish would result from exposure to sound.

Studies of the effects of long-duration sounds with sound pressure levels below 170–180 dB re 1 µPa indicate that there is little to no effect of long-term exposure on species that lack notable anatomical hearing specialization (Amoser and Ladich 2003; Scholik and Yan 2001; Smith et al. 2004a, 2004b; Wysocki et al. 2006). The longest of these studies exposed young rainbow trout (*Onorhynchus mykiss*) to a level of noise equivalent to one that fish would experience in an aquaculture facility (e.g., on the order of 150 dB re 1 µPa) for about nine months. The investigators found no effect on hearing (i.e., TTS) as compared to fish raised at 110 dB re 1 µPa. Though these studies have not directly determined impacts to the fish expected to be present within the Study Area, it can be assumed that they would react in a similar manner to sound exposure.

Behavioral responses to noise in wild fish could alter the behavior of a fish in a manner that would affect its way of living, such as where it tries to locate food or how well it can locate a potential mate. Behavioral responses to loud noise could include a startle response, such as the fish swimming away from the source, the fish "freezing" and staying in place, or scattering (Popper 2003a).

Fish use sounds to detect both predators and prey, and for schooling, mating, and navigating (Myrberg 1981; Popper 2003b). Masking of sounds associated with these behaviors could have impacts to fish by reducing their ability to perform these biological functions. Any noise (i.e., unwanted or irrelevant sound, often of an anthropogenic nature) detectable by a fish can prevent the fish from hearing biologically important sounds including those produced by prey or predators (Myrberg 1981; Popper 2003b). The frequency of the sound is an important consideration for fish because many marine fish are limited to detection of the particle motion component of low frequency sounds at relatively high sound intensities (Amoser and Ladich 2005). The frequencies of the acoustic transmissions associated with the Proposed Action are higher than those expected to be perceived by those species within the Study Area; therefore, masking is not likely as the mid- and high-frequency sources are not within the hearing range a fish would use to detect predators or prey. Behavioral responses are possible for those fish close to the active sonar sources, but there is little evidence of these responses at the frequency levels on the ICEX activities.

Acoustic transmissions from both Alternatives 1 and 2 would result in the same potential for effects to fish. There is a low likelihood that fish within the Study Area would be able to perceive the acoustic transmissions, and if perceived, that an individual animal would react; this reaction would be temporary or minimal, and the animal would be expected to resume normal behavior after exposure.

4.1.1.3 Essential Fish Habitat

Acoustic transmissions could have an effect on the features of the Essential Fish Habitat due to the increase in ambient sound level during the transmissions. However, this potential reduction in the quality of the acoustic habitat would be localized to the area of the training and research activity, and temporary in duration. The quality of the water column environment as Essential Fish Habitat would be restored to normal levels immediately following the completion of each individual training event, which would only occur for a few hours over a period of a couple of weeks. Secondary effects to federally managed fish species (i.e., Arctic cod) are considered in Section 4.1.1.2 above.

Acoustic transmissions from both Alternatives 1 and 2 would result in the same potential effects to Essential Fish Habitat. The quality of the water column as Essential Fish Habitat would only be affected locally and temporarily and the quantity would not be adversely impacted.

4.1.1.4 Mammals (Marine)

The only marine mammals susceptible to impacts from acoustic transmissions from the Proposed Action are ringed seals and bearded seals, as polar bears are anticipated to remain on the ice surface and not be exposed to acoustic transmissions in the water column. In assessing the potential effects on ringed and bearded seals from the Proposed Action, a variety of factors must be considered, including source characteristics, animal presence, animal hearing range, duration of exposure, and impact thresholds for species that may be present. Potential acoustic impacts could include PTS, TTS, or behavioral effects. To make these assessments, a model was used to quantitatively estimate the potential number of exposures that could occur, followed by a qualitative analysis to account for other factors not reflected by the model.

The Navy Acoustic Effects Model (NAEMO) was used to produce a quantitative estimate of PTS, TTS, and behavioral exposures for ringed and bearded seals (See Appendix F for additional details on NAEMO and the modeling process). The Navy then further analyzed the data and conducted an in-depth qualitative analysis of the species distribution and likely responses to the acoustic transmissions based on available scientific literature. The determination of the effects to the ringed seal and bearded seal was based on this combination of quantitative and qualitative analyses.

4.1.1.4.a Quantitative Analysis

A quantitative analysis of the potential effects to ringed and bearded seals from the proposed acoustic transmissions was conducted using a method that calculates the total sound exposure level and maximum sound pressure level that a bearded or ringed seal may receive from the acoustic transmissions. NAEMO was used for all modeling analysis (U.S. Department of the Navy 2017b). Environmental characteristics (e.g., bathymetry, wind speed, and sound speed profiles) and source characteristics (i.e., source level, source frequency, transmit pulse length and interval, horizontal and vertical beam width and source depth) were used to determine the propagation loss of the acoustic energy, which was calculated using the Comprehensive Acoustic

System Simulation/Gaussian Ray Bundle (CASS/GRAB) propagation model. Additionally, an under-ice model (OAML ICE) for surface interaction was implemented in NAEMO. The propagation loss then was used in NAEMO to create acoustic footprints. The NAEMO model then simulated source movement through the Study Area and calculated sound energy levels around the source. Animats, or representative animals, were distributed based on density data obtained from the Navy Marine Species Density Database (U.S. Department of the Navy 2017d). The Navy used a Seasonal Relative Environmental Suitability model (Kaschner et al. 2006), based on seasonal habitat preferences and requirements of known occurrences, such as temperature, bathymetry, and distance to land data and literature review, because occurrence information for bearded or ringed seals in the Study Area is not well known. Empirical data is coupled with Relative Environmental Suitability modeling data to generate predictions of density data for locations where no survey data exist. The energy received by each animat distributed within the model was summed into a total sound exposure level. Additionally, the maximum sound pressure level received by each animat was also recorded.

NAEMO provides two outputs. The first is the number of animats recorded with received levels within 1 dB bins at and greater than 120 dB re 1 μPa and the total sound exposure level (in dB re 1 $\mu Pa^2 \cdot s$) for each animat, prior to effect thresholds being applied (referred to as unprocessed animat exposures). These results are used to determine if a marine mammal may be exposed to the acoustic energy resulting from the Proposed Action, but they do not infer that any such exposure results in an effect to the animal from the action. The second output, referred to as calculated exposures, is the predicted number of exposures that could result in effects as determined by the application of acoustic threshold criteria. Criteria and thresholds for measuring these effects induced from underwater acoustic energy have been established for phocids. The thresholds established for physiological effects (sound exposure levels for PTS and TTS) and behavioral effects are provided in Table 4-1 and are described in detail in National Marine Fisheries Service (2016).

Table 4-1. In-Water Criteria and Thresholds for Predicting Physiological and Behavioral Effects on Marine Mammals Potentially Occurring in the Study Area

Group	Behavioral Criteria	Physiological Criteria	
		Onset TTS	Onset PTS
Phocidae (in water)	Pinniped Dose Response Function*	181 dB SEL cumulative	201 dB SEL cumulative

*See Figure 4-1

Behavioral response criteria are used to estimate the number of exposures that may result in a behavioral response. The Navy has defined a mathematical function used to predict potential behavioral effects (Figure 4-1 provides the function used for pinnipeds). This analysis assumes that the probability of eliciting a behavioral response from individual animals to active transmissions would be a function of the received sound pressure level (dB re 1 μPa). This analysis also assumes that sound poses a negligible risk to marine mammals if they are exposed to sound pressure levels below a certain basement value (120 dB re 1 μPa). Details regarding the behavioral risk function are provided in Department of the Navy (2017a).

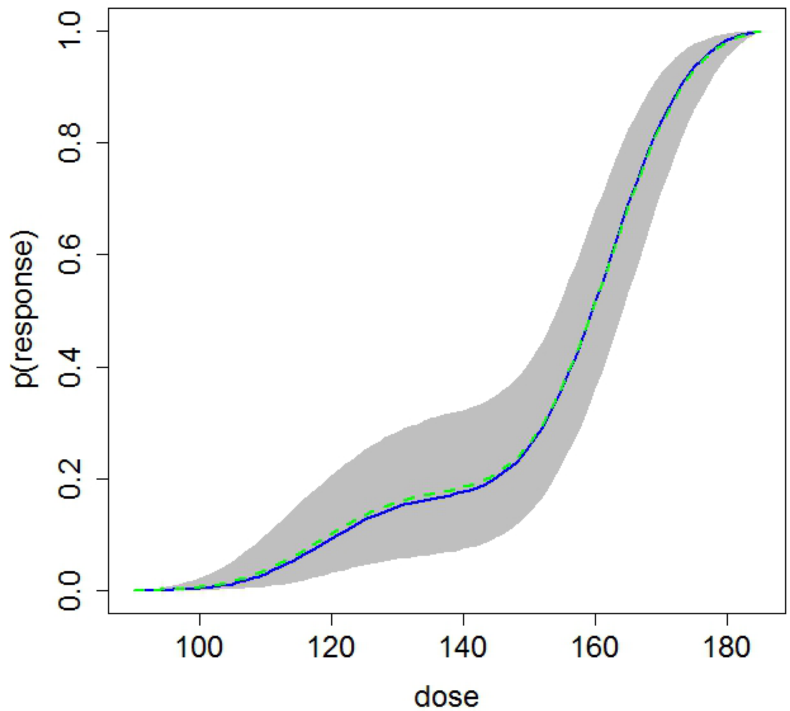


Figure 4-1. The Bayesian biphasic dose-response BRF for Pinnipeds.
The blue solid line represents the Bayesian Posterior median values, the green dashed line represents the biphasic fit, and the grey represents the variance. [X-Axis: Received Level (dB re 1 μPa), Y-Axis: Probability of Response]

Table 4-2 shows the exposures expected for the seals based on NAEMO modeled results looking at the acoustic sources specifically planned for use during the 2022 ICEX. Due to possible changes in acoustic modeling (i.e., change in sources used, number of sonar hours, or updates to marine mammal criteria and thresholds), the Navy will continue to model for potential acoustic exposures to marine mammals. If future modeling indicates an increase in estimated acoustic exposures to ESA-listed marine mammals, the Navy will reinitiate consultation for acoustic transmissions. 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 an ICEX event, and the implementation of mitigation measures would further limit actual exposures.

Table 4-2. Quantitative Modeling Results of Potential Exposures for 2022 ICEX Activities

Species	PTS (sound exposure level of 201 dB re 1 μ$Pa^2 \cdot s$)	TTS (sound exposure level of 181 dB re 1 μ$Pa^2 \cdot s$)	Behavior
Bearded Seal	0	3	10
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.

4.1.1.4.b Qualitative Analysis

No research has been conducted on the potential behavioral responses of pinnipeds to the type of acoustic sources used during the Proposed Action. However, data are available on (1) effects of non-impulsive sources (e.g., sonar transmissions) on other phocids in water, and (2) reactions of ringed seals while in subnivean lairs. All of this available information was assessed and incorporated into the findings of this analysis.

Effects of Non-impulsive Sources on Phocids in Water

For non-impulsive sounds (i.e., similar to the sources used during the Proposed Action), data suggest that exposures of pinnipeds to sources between 90 and 140 dB re 1 µPa do not elicit strong behavioral responses; no data were available for exposures at higher received levels for Southall et al. (2007) to include in the severity scale analysis. Reactions of harbor seals (*Phoca vitulina*) were the only available data for which the responses could be ranked on the severity scale. For reactions that were recorded, the majority (17 of 18 individuals/groups) were ranked on the severity scale as a 4 (moderate change in movement, brief shift in group distribution, or moderate change in vocal behavior) or lower; the remaining response was ranked as a 6 (minor or moderate avoidance of the sound source). Additional data on hooded seals (*Cystophora cristata*) indicate avoidance responses to signals above 160–170 dB re 1 µPa (Kvadsheim et al. 2010), and data on grey (*Halichoerus grypus*) and harbor seals indicate avoidance response at received levels of 135–144 dB 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 re 1 µPa at 1 m) were attached to ringed seals (Wartzok et al. 1992a; Wartzok et al. 1992b). An acoustic tracking system then was installed in the ice to receive the acoustic signals and provide real-time tracking of ice seal movements. Although the frequencies used in this study are at the upper limit of ringed seal hearing, the ringed seals appeared unaffected by the acoustic transmissions, as they were able to maintain normal behaviors (e.g., finding breathing holes).

Seals exposed to non-impulsive sources with a received sound pressure level within the range of calculated exposures, (142–193 dB re 1 µPa), have been 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).

Effects on Ringed Seals within Subnivean Lairs

Adult ringed seals spend up to 20 percent of the time in subnivean lairs during the timeframe of the Proposed Action (Kelly et al. 2010). Ringed seal pups spend about 50 percent of their time in the lair during the nursing period (Lydersen and Hammill 1993). Ringed seal lairs are typically used by individual seals (haul-out lairs) or by a mother with a pup (birthing lairs); large lairs used by many seals for hauling out are rare (Smith and Stirling 1975). The acoustic modeling does not account for seals within subnivean lairs, and all animals are assumed to be in the water and susceptible to hearing acoustic transmissions 100 percent of the time. Therefore, the acoustic modeling output likely represents an overestimate given the percentage of time that ringed seals are expected to be in subnivean lairs, rather than in the water. Although the exact amount of transmission loss of sound traveling through ice and snow is unknown, it is clear that some sound attenuation would occur due to the environment itself. In-air (i.e., in the subnivean lair), the best hearing sensitivity for ringed seals has been documented between 3 and 5 kHz; at higher frequencies, the hearing threshold rapidly increases (Sills et al. 2015).

If the acoustic transmissions are heard and are perceived as a threat, ringed seals within subnivean lairs could react to the sound in a similar fashion to their reaction to other threats, such as polar bears and Arctic foxes (their primary predators), although the type of sound would be novel to them. Responses of ringed seals to a variety of human-induced noises (e.g., helicopter noise, snowmobiles, dogs, people, and seismic activity) have been variable; some seals entered the water and some seals remained in the lair (Kelly et al. 1988). However, in all instances in which observed seals departed lairs in response to noise disturbance, they subsequently reoccupied the lair (Kelly et al. 1988).

The Proposed Action would overlap with the beginning of the ringed seal pupping season, but would be concluded before the height of the pupping season. Ringed seal mothers have a strong bond with their pups and may physically move their pups from the birth lair to an alternate lair to avoid predation, sometimes risking their lives to defend their pups from potential predators (Smith 1987). Additionally, it is not unusual to find up to three birth lairs within 100 m of each other, probably made by the same female seal, as well as one or more haul-out lairs in the immediate area (Smith et al. 1991). If a ringed seal mother perceives the acoustic transmissions as a threat, the network of multiple birth and haul-out lairs allows the mother and pup to move to a new lair (Smith and Hammill 1981; Smith and Stirling 1975). However, the acoustic transmissions are unlike the low frequency sounds and vibrations felt from approaching predators. Additionally, the acoustic transmissions are not likely to impede a ringed seal from finding a breathing hole or lair, as captive seals have been found to primarily use vision to locate breathing holes and no effect to ringed seal vision would occur from the acoustic transmissions (Elsner et al. 1989; Wartzok et al. 1992a). It is anticipated that a ringed seal would be able to relocate to a different breathing hole relatively easily without impacting their normal behavior patterns.

4.1.1.4.c Summary

The behavioral responses of ringed seals and bearded seals to underwater sound vary. Non-impulsive sources have been shown to elicit minor or moderate avoidance responses from other phocids at the sound pressure levels potentially received from the Proposed Action.

Submarine training and research activities would occur over an approximate four-week period during ICEX. During this time, the submarines, UUVs, and any active buoys would conduct intermittent acoustic events, and even during these events acoustic transmissions are not constant. The training and testing would occur in different locations and at different depths and speeds depending on the objective of the event. Transmissions from the submarines would occur within different locations but within the general area around the ice camp, so that they are within the tracking range acoustic boundary. As such, the likelihood of a single lair being exposed to the submarine activity for the entirety of the four-week period is low and encountering a bearded seal, unlikely. Additionally, as the acoustic transmissions would not be conducted continuously for the four-week period, the short duration of the events would result in only short term reactions by ringed seals or bearded seals (if present), after which time normal behavior would resume (Harris et al. 2001; Kvadsheim et al. 2010). An individual ringed seal or bearded seal could potentially react to the acoustic transmissions by alerting to or temporarily avoiding the area close to the source (e.g., using a breathing hole/lair further from the source). Data show that likely reactions would be within the normal repertoire of the animal's typical movements, as ringed seals routinely utilize a complex of breathing holes and lairs (Kelly et al. 1986; Smith and Hammill 1981; Smith and Stirling 1975). As most lairs are only used by single seals or by a mother-pup pair, acoustic transmissions would not result in a significant abandonment of a haul-out location by many seals. These and similar reactions would not disrupt the animal's overall behavioral pattern (e.g., feeding or nursing), and would therefore not affect the animal's ability to survive, grow, or reproduce.

As described above, the sound sources in the Proposed Action are expected to result in, at most, minor to moderate avoidance responses of animals, over short and intermittent periods of time. The Proposed Action is not expected to cause significant disruptions such as mass haul outs, or abandonment of breeding, that would result in significantly altered or abandoned behavior patterns. Since the acoustic transmissions from the Proposed Action may cause a behavioral effect (e.g., seal temporarily avoiding an area or using a different subnivean lair farther away from acoustic transmissions) and TTS, the Navy applied for an Incidental Harassment Authorization from NMFS for Level B take of bearded and ringed seals in accordance with the MMPA. However, bearded seals have a low probability of being encountered near Prudhoe Bay based on their seasonal movements to the Bering Sea during the winter season (Burns and Frost 1979; Cameron and Boveng 2007; Cameron and Boveng 2009; Frost et al. 2005; Frost et al. 2008) and association with drifting pack ice during late winter and early spring (Muto et al. 2016). In addition, following consideration of mitigation measures that would be put in place (see Chapter 6), acoustic transmissions associated with both Alternative 1 and Alternative 2 would not result in take of bearded seals under the MMPA, as any remaining possible exposures would be temporary and would not be likely to disrupt normal behavior patterns to a point that they would be abandoned or significantly altered.

Given this, in accordance with the ESA, the acoustic transmissions in the Proposed Action may affect, and is likely to adversely affect, ringed seals.

4.1.2 Aircraft Noise

Multiple types of aircraft would be used during the Proposed Action, including commercial small twin-engine fixed-wing aircraft, commercial rotary-wing aircraft (helicopters), military fixed-wing and rotary-wing aircraft, and two types of unmanned aerial systems. Logistics flights to and from the ice camp would originate at Deadhorse Airport, which currently supports approximately 60 daily flights. ICEX would only increase air traffic from the airport by 15 percent (maximum of 9 trips per day). Though some of the aircraft used during an ICEX event (such as the unmanned aerial systems) are small, most aircraft would create enough noise to potentially affect biological resources, during an ICEX event. During a Beta camp, only 9 round trips would be conducted, by a commercial fixed-wing aircraft, if constructed on the ice flow and only one round trip per day for pioneering if constructed on an inland lake. Noise may affect biological resources in a variety of ways. Aircraft make noise in flight, which propagates through the air. This sound also interacts with the ice surface and potentially propagates through the ice into the water. Lastly, aircraft spend time on the ice warming up, taxiing, and taking off and landing, all of which produce noise and are considered herein.

Sound generated by aircraft is analyzed for both in-air and in-water effects. Airborne sound levels are normally expressed in decibels (dB). The decibel value is given with reference to ("re") the value and unit of the reference pressure. The standard reference pressures are 1 μPa for water and 20 μPa for air. It is important to note that, because of the difference in reference units between air and water, the same absolute pressure would result in different dB values for each medium. In air, sound levels are frequently "A-weighted" and seen in units of dBA (A-weighted decibels).

Transmission of sound from a moving airborne source to a receptor underwater is influenced by numerous factors and has been addressed by Urick (1983), Young (1973), Richardson et al (1995), Eller and Cavanagh (2000), Laney and Cavanagh (2000), and others. Sound is transmitted from an airborne source to a receptor underwater by four principal means: (1) a direct path, refracted upon passing through the air-water interface; (2) direct-refracted paths reflected from the bottom in shallow water (not applicable here given the depth of the water in the Study Area); (3) evanescent transmission in which sound travels laterally close to the water surface; and (4) scattering from interface roughness due to wave motion (not applicable here given anticipated ice cover).

Airborne sound is refracted upon transmission into water because sound waves move faster through water than through air (a ratio of about 0.23:1). Based on this difference, the direct sound path is reflected if the sound reaches the surface at an angle more than 13 degrees from vertical. As a result, most of the acoustic energy transmitted into the water from an aircraft arrives through a relatively narrow cone extending vertically downward from the aircraft (Figure 4-2). The intersection of this cone with the surface traces a "footprint" directly beneath the flight path, with the width of the footprint being a function of aircraft altitude. Sound may enter the water outside of this cone due to surface scattering and as evanescent waves, which travel laterally near the water surface.

The inhomogeneous nature of sea ice does not necessarily allow for attenuation of noise from the air through the ice layer and into the water. At frequencies less than 500 Hz, which is the acoustic energy range of most aircraft, the ice layer is acoustically thin and causes little attenuation of sound (Richardson et al. 1991). This implies that low frequency sound travelling through the sea ice would only be slightly lower than that same noise travelling directly from the air to the water. (Richardson et al. 1995). Use of the air-water transmission model would provide slight overestimates of underwater sound levels from aircraft overflights, but this is the best model available to analyze airborne sound transmission through ice, allowing for a qualitative analysis of impacts on bearded seals under sea ice (Richardson et al. 1995).

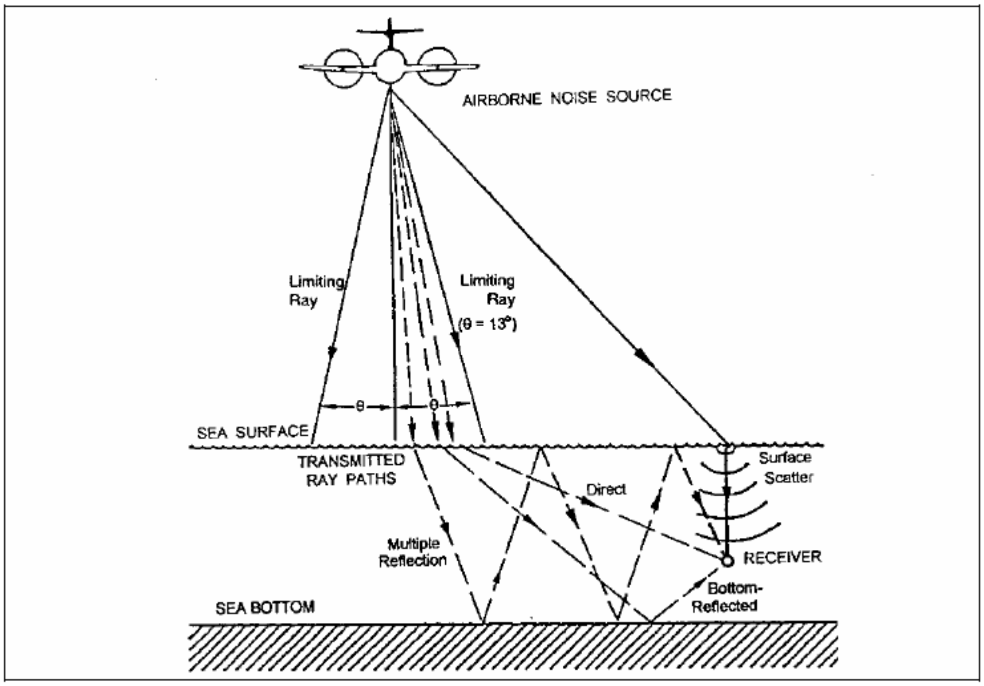


Figure 4-2. Characteristics of Sound Transmission through the Air-Water Interface
(Richardson et al 1995)

Table 4-3 provides a list of manned aircraft similar to those used during the Proposed Action and their associated in-air and in-water source levels. In addition to the manned aircraft, two unmanned aerial systems would be utilized during the Proposed Action. The fixed-wing unmanned aerial system is similar to, but smaller than, small fixed-wing aircraft (Piper PA-46-500TP, Cessna 180, and Cessna 185) included in the table below. The rotary-wing unmanned aerial system operates in a similar manner as helicopters, but on a smaller scale. Acoustic data for the unmanned fixed-wing aerial systems are not currently available, but based on the small size of the systems and their engines, it is not anticipated that they would create enough sound to cause a disturbance for the resources within the Study Area. 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 unmanned aerial system 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 unmanned aerial systems 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 (Christiansen et al. 2016; Southall et al. 2007).

Table 4-3. Source Levels of Representative Aircraft[1]

Aircraft Description	*Aircraft Altitude (ft)[2]*	*Frequency (Hz)*	*In-air Source Level (dB re 20 µPa)*	*In-water Source Level (dB re 1 µPa)[3]*
Fixed-wing takeoff	300	125		106
Fixed-wing (Piper PA-46-500TP)	25,000[2]	1700	73.7	
Fixed-wing (Cessna 180)	17,700[2]	1700	63-69	
Fixed-wing (Cessna 185)	17,900[2]	1700	64-66	
Fixed-wing (C-130)	300	63		170
Fixed-wing (F/A-18)	5000		85	
Fixed-wing (V-22)[5]	400		94	
Rotary-wing (H-60)	50			125
Rotary-wing warmup	-	160		131[4]
Rotary-wing (Bell 250)	300	200		155
Rotary-wing (Sikorsky S61)	300	40		156
Rotary-wing (V-22)[6]	100		94.6	

Note: ft = feet; dB re 20 µPa = decibels referenced to 20 microPascals
[1] All source level information was obtained from Malme et al (1989), Federal Aviation Administration (2012), and Department of the Navy (1999).
[2] Where no altitude was given for flyovers, maximum aircraft cruising altitude was assumed, based on cruise ceiling values from Aircraft Owners and Pilots Association (2015).
[3] Depth of measurement is 1 m, unless otherwise noted.
[4] Measurement taken at a depth of 20 m under ice.
[5] Nacelle angle at 0 degrees; lateral offset of 500 ft, flight speed 228 knots
[6] Nacelle angle at 90 degrees; lateral offset 500 ft, hovering condition.

Fixed-wing aircraft noise propagates through air at rates depending on factors such as frequency, temperature, relative humidity, and atmospheric pressure (Richardson et al. 1995). At middle frequencies, sound absorption has more influence on sound transmission in the atmosphere than in the ocean; for example, at 1 kHz the underwater sound absorption coefficient is approximately 0.06 decibels per kilometer (dB/km), whereas the typical value for in-air attenuation is approximately 4 dB/km. The absorption coefficient for in-air attenuation decreases rapidly with frequency to approximately 130 dB/km at 10 kHz, depending on temperature and humidity; thus, only low-frequency sound is transmitted well in air. It has been noted that the takeoff noise levels 1 m under the ice for small fixed wing aircraft is 106 dB re 1 µPa at 125 Hz (Malme et al. 1989). Aircraft on takeoff and landing tend to be noisier than those during cruising or especially approaching.

During the Proposed Action, small, fixed-wing aircraft (the most frequently used aircraft) would generally operate at altitudes up to 3,500 m. At this altitude, the footprint of airborne noise at the ice surface would be an approximate 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. As noise levels would be lowered by the time they reach the surface from an overhead flight, the noise levels would have decreased; these noise levels would still have to attenuate through the ice, and therefore underwater noise would be generally brief in nature.

Helicopter flights associated with the Proposed Action are used for logistical purposes (transport of personnel and equipment) and are not conducting training or testing and therefore would not be hovering or flying a route pattern for an extended period. Helicopters produce low-frequency sound and vibration (Pepper et al. 2003; Richardson et al. 1995). Helicopter sounds 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.

As of July 2019, the total operations of Deadhorse Airport, in Prudhoe Bay, including air carrier, air taxi, general aviation local, general aviation international, and military, was 21,324 flights (Airport Data and Information Portal 2021). Assuming an even distribution throughout the year, the average number of daily flights served by this airport is approximately 60. Though ICEX events could increase the daily number of flights by 15 percent during ice camp build-up and demobilization (the maximum number [9] of daily flights that could go to the ice camp), the duration of the Proposed Action is temporary, and overall there are a low number of flights, so the effects of additional air traffic would not be significant. The addition of the flights during an ICEX event would not reach the level of daily activity that the Deadhorse Airport has supported in the past (i.e., 32,912 flights during fiscal year 2015 (Federal Aviation Administration 2017)). Aircraft flights could additionally be associated with Beta camps, though they would be of less frequency as they would only be conducted for ice floe investigation or for a shorter camp with less personnel and equipment over a period of one week.

It is not anticipated that aircraft noise would impact marine habitats, vegetation, invertebrates, or fish, as the transmission of airborne noise through the ice would be limited, and outside of the hearing sensitivity of the applicable resources. Therefore, they are not further discussed. The only potential effects would be on marine birds and mammals (both marine and terrestrial), analysis for these species are provided below.

4.1.2.1 Marine Birds

Most migrating birds would be present below the altitude of fixed-wing aircraft flights, but could potentially be exposed to nearby noise from helicopters at lower altitudes. Altitudes at which migrating birds fly can vary greatly based on the type of bird, where they are flying (over water or over land), and other factors such as weather. Approximately 95 percent of bird flight during migrations occurs below 3,048 m with the majority below 914 m (Lincoln et al. 1998). While there is considerable variation, the favored altitude for most large birds varies based upon wind currents, and some have been observed flying at heights just above sea level to over 6,000 m (Warnock et al. 2002).

Unlike fixed-wing aircraft, helicopters typically operate below 305 m in altitude and often as low as 23–30 m. This low altitude increases the likelihood that birds would respond to noise from helicopter overflights. Helicopters travel at slower speeds (less than 100 knots), which increases durations of noise exposure compared to fixed-wing aircraft. In addition, some studies have suggested that birds respond more to noise from helicopters than from fixed-wing aircraft (Larkin et al. 1996). Noise from low-altitude helicopter overflights may elicit short-term behavioral or physiological responses, such as alert responses, startle responses, or temporary increases in heart rate, in exposed birds. Repeated exposure of individual birds or groups of birds is unlikely, based on the dispersed nature of the overflights and that birds would not be resident in the area during the Proposed Action. The general health of individual birds would not be compromised.

If a bird is close to an intense sound source, it could suffer auditory fatigue. Studies have examined hearing loss and recovery in only a few species of birds, and none studied hearing loss in marine birds (Hashino et al. 1988; Ryals et al. 1999; Ryals et al. 1995; Saunders et al. 1974). A bird may experience PTS if exposed to a continuous sound pressure level over 110 dBA re 20 µPa in air. Continuous noise exposure at levels above 90-95 dB(A) re 20 µPa can cause TTS (Dooling et al. 2012), while physical damage to birds' ears occurs with short-duration but very loud sounds (>140 dBA re 20 µPa for a single blast or 125 dBA re 20 µPa for multiple blasts) (Dooling and Popper 2007). Unlike many other species, birds have the ability to regenerate hair cells in the ear, usually resulting in considerable anatomical, physiological, and behavioral recovery within several weeks. Still, intense exposures are not always fully recoverable, even over periods up to a year after exposure, and damage and subsequent recovery vary significantly by species, though a species' appearance, behavior, or lifestyle cannot be used to predict the time-course of loss or recovery from acoustic trauma (Dooling and Popper 2007; Ryals et al. 1999). Though hair cell regeneration may restore hearing sensitivity, there are subtle, enduring changes to complex auditory perception, though these changes do not appear to provide any obstacle to future auditory and vocal learning for affected birds (Ryals et al. 2013). Birds may be able to protect themselves against damage from sustained sound exposures by regulating inner ear pressure, an ability that may protect ears while in flight (Ryals et al. 1999).

Chronic stress due to disturbance may compromise the general health and reproductive success of birds (Kight et al. 2012), but a physiological stress response is not necessarily indicative of negative consequences to individual birds or to populations (Bowles et al. 1991; National Parks Service 1994). It is possible that individuals would return to normal almost immediately after exposure, and the individual's metabolism and energy budget would not be affected long-term. Studies have also shown that birds can habituate to noise following frequent exposure and cease to respond behaviorally to the noise (Larkin et al. 1996; National Park Service 1994; Plumpton 2006). However, the likelihood of habituation is dependent upon a number of factors, including species of bird (Bowles et al. 1991), and frequency of and proximity to exposure. A study by Komenda-Zehnder et al. (2003) examined the stressed behavioral shift during airplane and helicopter overflights at different altitudes. They observed that flights operating at lower altitudes elicited a greater behavioral response, and that larger, slower moving aircrafts also lead to greater stressed response. However, this study also concluded that the stressed behaviors exhibited decreased to a normal level around five minutes after the overflight occurred; thus the behavioral responses were temporary and of very short duration.

Responses by birds to aircraft overflights include flying, swimming (which would not be applicable within the Study Area), and displaying alert behaviors (Conomy et al. 1998; Mallory 2016; Ward et al. 1999). Even if a behavioral response is not observed, studies have shown that birds physiologically may be affected based on increased heart rates during aircraft overflights (Wooley Jr. and Owen Jr. 1978). Occasional startle or alert reactions to aircraft are not likely to disrupt major behavior patterns (such as migrating) or to result in serious injury to any marine bird. Helicopter overflights would be more likely to elicit responses than fixed-wing aircraft, but the general health of individual birds would not be compromised.

Aircraft noise associated with Alternative 1 would be from all flight associated with ICEX events in the ice camp study area. Noise associated with these aircraft may elicit responses in individual birds potentially migrating through the area. However, individual stress responses do not necessarily result in negative consequences to populations. Due to the limited duration of activities and the small number of birds that are expected to be around the camp on a sustained basis, population-level effects are not anticipated. Therefore, pursuant to the Migratory Bird Treaty Act, aircraft noise associated with this alternative would not result in a significant adverse effect on migratory bird populations.

Under Alternative 2, the number and types of aircraft flights would increase. Alternative 2 would result in additional fixed-wing overflights due to the biennial addition of flights associated with conducting a Beta camp. The increase in activity would increase the potential for birds to be exposed to aircraft noise. Although an increase in noise would occur under this alternative, reactions of birds would be limited to individuals migrating through the area. Additionally, individual stress responses do not necessarily result in negative consequences to populations. Due to the limited duration of activities (up to four hours per flight and one flight per day for unmanned aerial systems used in and around the ice camp) and the small number of birds that are expected to be around the camp on a sustained basis, population-level effects are not anticipated. As such, pursuant to the Migratory Bird Treaty Act, aircraft noise associated with this alternative would not result in significant adverse effects on bird populations.

4.1.2.2 Mammals (Marine and Terrestrial)

Potential effects to mammals from aircraft activity could involve both acoustic and non-acoustic 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). 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). Studies have shown both hauled out ringed and bearded seals sometimes react to low flying aircraft or helicopter by diving into the water (Alliston 1981; Burns 1970; Burns and Frost 1979; Burns and Harbo 1972; Burns et al. 1982). 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 relative wind direction. Mammal reactions to helicopter disturbance are difficult to predict, though helicopters have been recorded to elicit a stronger behavioral response from ringed and bearded seals than a fixed-wing aircraft (Born et al. 1999; Burns and Frost 1979). Furthermore, Perry et al. (2002) found sex and age compositions of haulout groups (for grey and harbor seals) are important factors in determining the severity of the reaction to aircraft. Salter (1979) studied the Atlantic walrus and concluded small groups of pinnipeds composed of either adolescent seals or mother pup pairs have been shown to react most strongly. During the breeding season females were more alert than males (Perry et al. 2002).

More studies have been conducted on ringed seals reaction to aircraft noise than bearded seals. Due to the fact that they are both pinnipeds and are both ice obligate species reactions of both species are thought to be similar. The response by ringed seals to aircraft noise is variable based upon time of year, prevailing weather, and location. Another factor that could impact ringed seal response is whether the animal is hauled out or in a subnivean lair, as the subnivean response is typically stronger than that of a basking ringed seal (Burns et al. 1982). During the Proposed Action, ringed seals may be on the ice, but are more likely to be within their subnivean lairs or in the water during this period. Bearded seals may be hauled out on the ice or in the water (since they can maintain breathing holes in the ice with their claws and foreflippers) (Reeves et al. 2002) near Prudhoe Bay during the Proposed Action. Ringed seals were shown to leave their subnivean lairs and enter the water when a helicopter was at an altitude of less than 305 m and within 2 km lateral distance (Richardson et al. 1995). However, 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 would be a suitable alternative in the event they leave a lair directly below the flightpath of an aircraft. Observations of ringed seals within the water column showed some ringed seals surfaced 20–30 m from the edge of an ice sheet only a few minutes after a helicopter had landed and shut down near the ice edge (Richardson et al. 1995). However, the specific responses by ringed seals to aircraft have not been observed frequently.

Overall, there has been no indication that single or occasional aircraft flying above pinnipeds in water cause long term displacement of these animals (Richardson et al. 1995). The lowest observed adverse effects levels are rather variable for pinnipeds on land, ranging from just over 150 m to about 2,000 m (Efroymson and Suter 2001). A conservative (90th percentile) distance effects level is 1,150 m. Most thresholds represent movement away from the overflight. As a general statement from the available information, pinnipeds exposed to intense (approximately 110 to 120 dB re 20 μPa) non-pulse sounds often leave haul-out areas and seek refuge temporarily (minutes to a few hours) in the water (Southall et al. 2007). Per Richardson et al. (1995), approaching aircraft generally flush animals into the water and noise from a helicopter is typically directed down in a ‘‘cone’’ underneath the aircraft. As bearded seals occur near the ice edge or on a large floe, seals would need to be located directly below the flight path of the aircraft, during takeoff or landing, to be affected.

Polar bears have been seen running away from helicopters flying at an altitude of less than 200 m or at a distance of less than 400 m (Richardson et al. 1995). A helicopter approaching close to a polar bear den does not usually cause the polar bear to abandon the den since snow greatly attenuates helicopter noise (Amstrup 1993; Blix and Lentfer 1992). It is unlikely that an individual would be exposed repeatedly for long periods of time due to the short duration of the aircraft overflights during the Proposed Action and that the ice camp would not likely be established near polar bear dens, considering the vast size of the polar bear home range and the small size of the ice camp. Therefore, the likelihood of a polar bear being under the flight path for multiple flights would be low. Any reactions to aircraft overflights would be short-term, infrequent, and would not be expected to disrupt major behavior patterns such as migrating, breeding, feeding, and sheltering, or injure any polar bears.

Research regarding the reactions of Arctic foxes to aircraft noise is not available. Research has been conducted on game-farm minks, which are also small predatory mammals. When minks were exposed to aircraft hidden from view there was little response and when the aircraft could be seen, minks oriented to the stimulus; no severe reactions were recorded (literature review in (Larkin et al. 1996)). Expected reactions range from looking up at a helicopter or fixed wing aircraft as it passes by to running away from the aircraft noise. Any reactions to aircraft overflights would be short-term, infrequent, and would not be expected to injure any Arctic foxes or disrupt natural behavior patterns such as migrating, breeding, feeding, and sheltering to the point where these behaviors would be abandoned or significantly altered.

Bearded seals have a low probability of being encountered near Prudhoe Bay based on their seasonal movements to the Bering Sea during the winter season (Burns and Frost 1979; Cameron and Boveng 2007; Cameron and Boveng 2009; Frost et al. 2005; Frost et al. 2008) and association with drifting pack ice during late winter and early spring (Muto et al. 2016). Additionally, there would only be a maximum of 9 flights per day to and from Deadhorse Airport during an ICEX event. This would only be a temporary 15 percent increase to the daily number of flights going into and out of Deadhorse Airport, as an ICEX event would occur over a six week duration and even less frequent during a Beta camp (total of 9 round trips to the ice camp, or one flight if Beta camp is located on an inland lake). Flight paths do not occur directly over any known haul out location.

Aircraft noise associated with Alternative 1 would be from all flights associated with ICEX events in the ice camp study area. Under ESA, noise associated with these aircraft may affect, but not likely to adversely affect, polar bears, bearded seals, and ringed seals. Aircraft noise associated with Alternative 1 would not result in takes under the MMPA, as any disturbances would be temporary and would not be likely to disrupt normal behavior patterns to a point that they would be abandoned or significantly altered.

Under Alternative 2, the number of aircraft flights would increase due to the yearly addition of flights associated with conducting a Beta camp. The increase in activity would minimally increase the potential for marine and terrestrial mammals to be exposed to aircraft noise due to the addition of flights in years with a Beta camp. Although an increase in noise would occur under this alternative, reactions of marine mammals would remain temporary and would not result in behaviors being significantly altered or abandoned. As a result, aircraft noise associated with Alternative 2 under ESA may affect, but not likely to adversely affect, polar bears, bearded seals, and ringed seals. Additionally, aircraft noise associated with Alternative 2 would not result in takes under the MMPA, as any disturbances would be temporary and would not be likely to disrupt normal behavior patterns to a point that they would be abandoned or significantly altered.

4.1.3 On-Ice Vehicle Noise

The use of on-ice vehicles throughout the Proposed Action is integral to ice camp logistics (e.g., personnel and equipment transport). The Beta camp would utilize small snowmobiles or small unit support vehicles for logistical purposes as needed.

Small snowmobiles create sounds at higher frequencies than larger, slower machinery. Measurements of frequency content and A-weighted sound levels (dBA) of snow machine pass- bys have been recorded (Menge et al. 2002). The sound level associated with snowmobiles is dependent upon the model, engine size, and speed of the snowmobile. 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 1600 Hz. Other studies have found different values for the amount of under-ice sound generated by snowmobiles. The spectrum of snowmobile sound as received under the ice includes much energy near 1–1.25 kHz in frequency, but source levels vary widely, from 90 dB re 1 μPa^2/Hz at range 148 m to 55–60 dB re 1 μPa^2/Hz at range of approximately 200 m in another (Holliday et al. 1980).

In addition to small snowmobiles and all-terrain tracked vehicles may be used to support runway extension from 762 m in length used for small commercial aircraft to 1,524 m in length needed to support military aircraft (i.e., LC-130). The runway prep sled that would be dragged behind a snowmobile is 3 m by 1.2 m by 0.6 m in size and 700 pounds (lb) in weight. Though limited information is available regarding the noise that small unit support vehicles produce, it is expected that they would have a similar sound profile as a Caterpillar tractor driving on the sea ice, which measured at an overall level of 77 dB re 1 µPa under the ice (Richardson et al. 1991). By extension, since Caterpillar tractors have a similar sound profile as the snowmobiles being used for the Proposed Action, it can then be inferred that the small unit support vehicles would produce source levels approximately the same as the snowmobiles. The all-terrain tracked vehicle would be similar in engine size as the snowmobiles and smaller than the small unit support vehicle. With the values for on-ice vehicle noise transmitting through the ice, it is important to remember that noise levels are affected by the ice condition, amount of snow on the ice, and other similar factors (Richardson et al. 1991). Snow blowers may be used for general runway and ice camp maintenance. At-ear measurements of snow blower noise have been taken to be more than 90 dBA (Pasanen et al. 2004; Roberts 2019).

It is not anticipated that on-ice vehicle noise would impact marine habitats, vegetation, invertebrates, fish, or Essential Fish Habitat, as the transmission of airborne noise through the ice would be limited, coupled with the limited hearing ability of these resources. Similarly, the on-ice vehicle noise propagated through the ice would be low enough (e.g., less than 124 dB re 1 µPa based on Malme et al (1989)) to have no potential to affect marine mammals that are below the sea ice. Therefore, none of these resources are discussed further with respect to on-ice vehicle noise. The potential effects from on-ice vehicle noise on marine birds and mammals (both marine and terrestrial) are provided below.

4.1.3.1 Marine Birds

As discussed in Section 3.2.2, those species that would be present in the Study Area during the Proposed Action would be predominantly foraging and migrating. They would not be engaging in activities, such as mating or reproducing, which would require them to remain in any given area for extended periods of time. The analysis of bird responses and effects from aircraft noise (Section 4.1.2.1) is similar to the anticipated potential responses from on-ice vehicle noise.

Noise associated with on-ice vehicles could elicit short-term behavioral or physiological responses, such as alert responses, startle responses, or temporary increases in heart rate. However, because of the short-term and temporary nature of these responses, the general health of an individual bird would not be compromised.

On-ice vehicle noise associated with Alternative 1 would be from snowmobiles and all-terrain tracked vehicles used to construct the aircraft runway and support logistics within the camp and research activities. Noise associated with on-ice vehicles may elicit responses in individual birds potentially foraging or migrating through the area. However, individual stress responses do not necessarily result in negative consequences to populations. Due to the limited duration of activities and the small number of birds that are expected to be around the camp on a sustained basis, population-level effects are not anticipated. Therefore, pursuant to the Migratory Bird Treaty Act, on-ice vehicle noise associated with this alternative would not result in a significant adverse effect on migratory bird populations.

Under Alternative 2, on-ice vehicle use would increase due to the addition of on-ice vehicles that would likely be used biennially to support the Beta camp. The execution of the research activities would require increased use of the on-ice vehicles within and near the ice camp to move personnel and equipment. Due to the limited scope of the Beta camp activities over the course of a one-week period, the addition of the Beta camp would only minimally increase on-ice vehicle usage. The increase in activity would slightly increase the potential for birds to be exposed to on-ice vehicle noise. Although an increase in noise would occur under this alternative, reactions of birds would be limited to individuals migrating through the area. Additionally, individual stress responses do not necessarily result in negative consequences to populations. Due to the limited duration of activities and the small number of birds that are expected to be around the camp on a sustained basis, population-level effects are not anticipated. As such, pursuant to the Migratory Bird Treaty Act, on-ice vehicle noise associated with this alternative would not result in significant adverse effects on migratory bird populations.

4.1.3.2 Mammals (Marine and Terrestrial)

Limited information is available on the effects of on-ice vehicle noise on mammals; information available for snowmobile noise is included herein. Since no studies have been conducted on the effects of noise from a small unit support vehicle or an all-terrain tracked vehicle and they emit a similar noise level to the snowmobile, it is expected that mammals would have a similar reaction to all-terrain tracked vehicles as they would to a snowmobile. Since snowmobiles and all-terrain tracked vehicles emit sound at a low received level under the ice (up to 124 dB re 1 μPa); no effect to seals from on-ice vehicle noise would occur while they are below the ice. Polar bears swim in open waters; no open water is located near the ice camp proposed action area. Therefore, no under-ice effect to polar bears from on-ice vehicle noise is anticipated. Additionally, bearded seals would not be located near the ice camp study area during the timeframe of the Proposed Action. Therefore, the impacts of on-ice vehicle noise on bearded seals are not further analyzed.

In a study by Andersen and Aars (2007) in Svalbard, Norway (an area of limited snowmobile traffic), two snowmobiles moved towards polar bears in a straight line at a speed between 30 and 40 km/hr. Snowmobiles would move towards where the polar bear was first seen until there was a flight response. At the time of the response, distances were measured between the snowmobile and the polar bear's original location. An important factor in this study was also the wind direction (which if moving in the direction of the snowmobile would enhance the sound or if blowing away from the snowmobile would reduce the sound). From this study, 20 polar bear reactions and distance of reactions were recorded. Reactions varied from walking away from the snowmobile and lifting its head, to running rapidly away from the snowmobile for an extended period of time. Female polar bears with cubs and medium sized polar bears had reactions at the farthest distances (1,534 m and 1,160 m, respectively) while adult females without cubs and males reacted at much closer distances (164 m and 326 m, respectively). Polar bears in this study were seen running for at least 1 km after disturbance from a snowmobile, and several bears left a ringed seal breathing hole where they were hunting. The snowmobiles in this study, however, were traveling in the direction of the polar bear to determine when the bear would react. During the Proposed Action, on-ice vehicles would not be used to follow a polar bear, and therefore their reactions are expected to be different. Polar bears have also been known to habituate to disturbances from snowmobiles. One female polar bear with a one year old cub stayed within a 50 km^2 area for three weeks despite heavy snowmobile presence. This area was a known, prime hunting habitat which was also inferred to be the reason why the bear tolerated such repeated disturbance (Andersen and Aars 2007; McLaren and Green 1985).

Snowmobiles may be used as a preventive measure to deter polar bears from an area for human safety. This deterrence includes using a snowmobile to patrol the periphery of the camp or by blocking their path with the noise made by the snowmobile. However, once a polar bear turns away from the human activity, the snowmobile would not follow or chase the animal, unless as part of an active deterrence measure for human safety. Since snowmobiles would be travelling mostly within the camp and along a few established routes in and out of the camp, any snowmobile disturbance would be localized.

Few studies are available on the reactions of Arctic foxes to snowmobiles. However, the short-term behavioral and physiological response of other species (e.g., muskoxen [*Ovibos moschatus*], mule deer [*Odocoileus hemionus*], and Svalbard reindeer [*Rangifer tarandus platyhunchus*]) to snowmobiles have been studied (Freddy et al. 1986; McLaren and Green 1985; Tyler 1991). Although individual responses varied, disturbance levels were generally low and no major negative effects from snowmobile disturbance were recorded. Additionally, habituation to snowmobile noise has also been recorded for these species (McLaren and Green 1985) and is expected to be similar for Arctic foxes.

Ringed seals in their subnivean lairs showed variable reactions to snowmobile noise (Burns et al. 1982; Kelly 1988b; Kelly et al. 1986). Some seals stayed within the subnivean lair when snowmobiles were greater than 2.8 km away, while one seal stayed within its lair when a snowmobile passed within 0.5 km (Richardson et al. 1995). Most (if not all) seals returned to their lairs after the sound had ceased. In a study by Green and Johnson (1982, no evidence of a lower ringed seal density existed within approximately 13 km of a highly-trafficked construction site compared to density in the region. However, within a few kilometers, the construction site density of ringed seal holes was lower, which could be attributed to localized displacement. Ringed seals will maintain subnivean lairs near their breathing holes, though some have adapted to moving to a nearby lair in the instance of a predatory threat (Hammill and Smith 1989; Smith et al. 1991). As it is easiest to establish the camp in flat terrain, the location for the ice camp would be selected to avoid smaller pressure ridges and snow drifts, if possible (see Chapter 5). 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 with an eye toward 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. Additionally, pups are not anticipated to be in the vicinity of the ice camp during operations, because any highly sensitive females would not likely whelp within the camp’s disturbance zone (whelping is not expected prior to mid-March), and therefore would not need to move newborn pups through the water farther from camp at a time when such movement could affect pup survival. Therefore, ringed seal responses to noise and vibration associated with on-ice vehicles is extremely unlikely to result in significant disruption of feeding or natural behavioral patterns.

On-ice vehicle noise associated with Alternative 1 would be from snowmobiles and all-terrain tracked vehicles used to construct the aircraft runway and support logistics within the camp and research activities. Noise associated with these vehicles under ESA, may affect, but not likely to adversely affect, polar bears and ringed seals. Reactions of marine mammals would remain temporary and within the animal’s normal repertoire of behaviors, and would not result in behavioral patterns being significantly altered or abandoned, therefore; on-ice vehicle noise associated with Alternative 1 would not result in incidental takes of marine mammals under the MMPA. However, the Navy has requested a permit for the intentional take of polar bears through the use of various deterrent methods, including vehicle movement (Appendix C), for purposes of human safety.

Under Alternative 2, on-ice vehicle use would increase due to the addition of on-ice vehicles that would likely be used biennially to support the Beta camp. The execution of the research activities would require increased use of the on-ice vehicles within and near the ice camp to move personnel and equipment. Due to the limited scope of the Beta camp activities over the course of a one-week period, the addition of the Beta camp would only minimally increase on-ice vehicle usage. As a result, on-ice vehicle noise associated with Alternative 2 under ESA, may affect, but not likely to adversely affect, polar bears and ringed seals. Although an increase in noise would occur under this alternative, reactions of marine mammals would remain temporary and within the animal’s normal repertoire of behaviors, and would not result in behavioral patterns being significantly altered or abandoned. Therefore, on-ice vehicle noise associated with Alternative 2 would not result in incidental takes under the MMPA. However, the Navy has requested a permit for the intentional take of polar bears through the use of various deterrent methods, including vehicle movement (Appendix C), for purposes of human safety.

4.2 PHYSICAL STRESSORS

Physical stressors resulting from the Proposed Action include aircraft strike, on-ice vehicle strike, in-water device strike, in-water vessel and vehicle strike, and human presence.

4.2.1 Aircraft Strike

The potential for aircraft strike is dependent upon the type of aircraft, altitude of flight, and speed of travel. Small, fixed-wing aircraft typically operate at altitudes up to 3,500 m, though most activities would occur below this altitude. Small, fixed-wing aircraft typically travel at speeds of 80–160 knots; large, fixed wing aircraft (C-130 and LC-130) have a maximum speed of 318 knots at an altitude of 6,100 m. Helicopters, by nature, would either be hovering or traveling at speeds up to 150 knots. Unmanned aircraft systems travel at a significantly slower speed than manned aircraft. The unmanned aerial system flights would occur for up to 4 hours per system per day.

Aircraft strike would have the potential to harm marine birds. Other natural and physical resources (such as marine and terrestrial mammals) would not have the potential to be impacted by aircraft strike. Therefore, only an analysis of the potential effects to birds is provided below.

The majority of bird flight is below 914 m and approximately 95 percent of bird flight during migrations occurs below 3,048 m (U.S. Geological Survey 2006). Bird and aircraft encounters are more likely to occur during aircraft takeoffs and landings than when the aircraft is engaged in level, low-altitude flight. In a study of reported bird strikes to civil aircraft from 1990 to 2005, 60 percent of strike occurred below 30.5 m, 74 percent of strike occurred below 150 m, and 92 percent of strike occurred below 610 m (Cleary et al. 2006). Bird strike potential is greatest in foraging or resting areas (which are not present in the Study Area), in migration corridors, and at low altitudes. Since 1981, naval aviators reported 16,550 bird strikes. About 90 percent of wildlife/aircraft collisions involve large birds or large flocks of smaller birds (Federal Aviation Administration 2003), and more than 70 percent involve gulls, waterfowl, or raptors. From 2000 to 2009, the Navy Bird Aircraft Strike Hazard program recorded 5,436 bird strikes with the majority occurring during the fall period from September to November. Though bird strikes can occur anywhere aircraft are operated, Navy data indicate they occur more often over land or close to shore.

Strike of a marine bird by an aircraft associated with the Proposed Action is possible, though not likely. Although marine birds are likely to hear and see approaching aircraft, they cannot avoid all collisions. Birds are known to be attracted to aircraft lights, which can lead to collisions (Gehring et al. 2009; Poot et al. 2008). Those marine bird species that would be found within the Study Area during the Proposed Action typically occur in groups smaller than 20 animals, though they may occasionally be in larger groups in the case of black guillemot (Section 3.2.2.1). In this context, the loss of several or even dozens of birds due to physical strikes would not constitute a population-level impact, as these species would not be gathered in large flocks. Some bird strikes and associated bird mortality or injuries could occur as a result of aircraft use; however, population-level impacts to marine birds would not likely result from aircraft strikes due to the limited duration of aircraft operation, the likely flight response of marine birds to in-air noise and general aerial disturbance, and the fact that marine birds are not likely to approach an aircraft while it is in operation (Mallory 2016).

Marine bird presence in the Study Area during the Proposed Action would be limited to those individuals wintering around the sea ice. As discussed in Section 3.2.2.1, the birds that are expected to be within the Study Area are only those who are year-round residents or non-migrating individuals within a species. Most of these birds are expected to occur singly or in flocks up to 20 individuals, though black guillemot may flock in larger groups due to highly concentrated prey species. Generally, large flocks of marine birds are not anticipated to cross through the Study Area during the timeframe of the Proposed Action; while there is the potential for strike with an aircraft of small numbers of individuals, it is unlikely. As previously described in Section 4.1.2, the increase in aircraft presence due to the Proposed Action would be approximately 15 percent. A temporary increase in daily flights, such as this, would not be expected to result in significantly increased risk to marine birds.

Under Alternative 1, the potential for aircraft strike would be from all flights associated with ICEX events in the ice camp study area. Although unlikely, aircraft strike with an individual marine bird is possible. However, because the birds are not expected to be traveling in large flocks, and aircraft operations would be limited to a few flights a day over the course of a few weeks, one or more isolated incidents of aircraft strike would not result in a significant adverse effect on migratory bird populations, pursuant to the Migratory Bird Treaty Act.

Under Alternative 2, the number of aircraft flights would increase due to the biennial addition of flights associated with conducting a Beta camp. The increase in activity would increase the potential for birds to be struck by aircraft, but only slightly. Although an increase in potential strike would occur under this alternative, the likelihood remains low and any impacts would be similarly limited to one or a small number of birds. As such, pursuant to the Migratory Bird Treaty Act, aircraft strike associated with this alternative would not result in significant adverse effects on migratory bird populations.

4.2.2 On-Ice Vehicle Strike

During the Proposed Action, snowmobiles and all-terrain tracked vehicles 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, on-ice vehicles may be used to establish the runway for 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. Snowmobiles would not be in constant use during these trips; they would transport personnel and equipment to an offsite location (generally up to 5 km without helicopter support) and then stand by until the experiment is complete before returning the personnel to the camp. Additionally, personnel movement on snowmobiles, both away from and around camp, would only occur during daylight hours, which would reduce the potential for striking an animal.

Lima et al. (2015) reviewed the reactions of various animal taxa to oncoming vehicles, and the likelihood of potential strike by the vehicle. In this review, animal-vehicle strike avoidance depends on an animal's threat assessment capabilities and avoidance response. Vehicles are not perceived as a predatory threat by many animals, but when a collision is immediately forthcoming animals typically will have a flight response to avoid the vehicle, engaging their anti-predator behavior.

On-ice vehicle strike would only have the potential to affect mammals (i.e., polar bears, arctic foxes, and ringed seals), with the exception of the bearded seal. Bearded seals would not be located near the ice camp study area during the timeframe of the Proposed Action. Therefore, the impacts of on-ice vehicle strike on bearded seals are not further analyzed. Marine birds are not expected to be nesting within the Study Area, and therefore would not be situated for long periods of time on the ice floe and available to be struck. Therefore, only an analysis of the potential effects to mammals is provided below.

Snowmobiles produce sound at source levels of 104 dBA re 20 µPa on average (Richardson et al. 1995), though sound would dissipate as it spreads away from the source. At this source level, all mammals in the area are capable of hearing the sound emitted from the snowmobile as well as see them approaching. Ringed seals would only be on the ice (and therefore susceptible to on-ice vehicle strike) while hauled out. 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. The basking period for the tagged seals started between 15 April and 31 May for the tagged seals. Since the timeframe of the Proposed Action is almost entirely outside of the molting season (when seals spend most of the time hauled out on the sea ice), the likelihood of an on-ice vehicle strike would be exceedingly remote. Additionally, snowmobiles are highly mobile vehicles and would move easily to avoid any mammal spotted nearby (see mitigation measures, Chapter 5), and the risk of collision is further reduced by the mammal's avoidance of any vehicle making noise nearby.

Ringed seal subnivean lairs are concentrated in areas of deep snow and are associated with large, thick ice ridges (Furgal et al. 1996). Although the best conditions for subnivean lairs are in deep snow, the depth of snow where subnivean lairs are built does vary. Lairs that are built in areas with less snow are more susceptible to predation, and if within the Study Area, could be susceptible to disturbance from on-ice vehicles. Since the density of lairs is very low in the Beaufort Sea pack ice, generally less than 0.2 per 1 nm^2 (Burns et al. 1982), and that pressure ridges would be avoided in selecting a camp location (Chapter 5), the potential for an on-ice vehicle to run over and disturb a lair (by altering a structure) is very unlikely.

Since polar bears spend minimal time in the water and Arctic foxes are a terrestrial species, the probability of encounters with on-ice vehicles are higher than for seals. Both the polar bear and the Arctic fox spend almost all of their time on the ice or on land. Polar bears will swim when open water is available (not expected during the timeframe of the Proposed Action), but most of their time is spent roaming the ice or stalking leads or breathing holes for prey. As stated in Section 4.1.3, all mammals in the area (polar bears, Arctic foxes, and ringed seals) are capable of hearing the snowmobile noise and have shown an avoidance response (running away or moving into the water) when a snowmobile is nearby. Therefore, the potential for a strike between a polar bear or Arctic fox and an on-ice vehicle would be extremely low. Snowmobiles are highly mobile vehicles and could move easily to avoid any mammal spotted nearby, and the risk of collision is also reduced by the mammal's avoidance of any vehicle making noise nearby.

Under Alternative 1, potential for on-ice vehicle strike would be from snowmobiles and all-terrain tracked vehicles used to construct the aircraft runway and support logistics within the camp and research activities. Under ESA, on-ice vehicle strike (and potential disturbance to ringed seal breathing holes), may affect, but not likely to adversely affect, ringed seals. Because of their large size (and sightability), and the fact that close contact with polar bears would be avoided for human safety, the potential for on-ice vehicle strike to polar bears is not expected. Therefore under ESA, no effect to polar bears from on-ice vehicle strike under Alternative 1 is anticipated. On-ice vehicle strike would not result in takes of marine mammals under the MMPA or ESA.

Under Alternative 2, on-ice vehicle use would increase due to the addition of on-ice vehicles that would likely be used biennially to support the Beta camp. The execution of the research activities would require increased use of the on-ice vehicles within and near the ice camp to move personnel and equipment. Due to the limited scope of the Beta camp activities over the course of a one-week period, the addition of the Beta camp would only minimally increase on-ice vehicle usage. Under ESA, on-ice vehicle strike (and potential disturbance to ringed seal breathing holes), may affect, but not likely to adversely affect, ringed seals. Because of their large size (and sightability), and the fact that close contact with polar bears would be avoided for human safety, the potential for on-ice vehicle strike to polar bears is not expected. Therefore under ESA, no effect to polar bears from on-ice vehicle strike under Alternative 2 is anticipated. On-ice vehicle strike would not result in takes of marine mammals under MMPA or ESA.

4.2.3 In-Water Vessel and Vehicle Strike

Submarines would be utilized during the Proposed Action during both Alternatives 1 and 2, and they would typically operate at speeds less than 10 knots. Unmanned underwater vehicles and associated towed arrays also have the potential to result in strike to marine resources (Alternative 2). Unmanned underwater vehicles are slow moving, typically less than 8 knots. Physical disturbance from the use of in-water devices is not expected to result in more than a momentary behavioral response. Any change to an individual animal's behavior from in-water devices is not expected to result in long-term or population-level effects. 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 invertebrates, fish, or marine mammals 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 (Heide-Jørgensen et al. 2003; Richardson et al. 1995).

In-water vessel and vehicle strike would not affect bottom substrates, as none of the vehicles would be at bottom depth, nor would they affect marine vegetation, marine birds, or terrestrial mammals. Additionally, in-water vessel and vehicle strike is not expected to affect bearded seals, as it is highly unlikely that bearded seals would occur near the ice camp or where the submarine activities will be conducted during the timeframe of the Proposed Action. The ice camp will be established 100-200 nmi (185-370 km) north of Prudhoe Bay in water depths of 800 m or more. Bearded seals feed heavily on benthic organisms (Hamilton *et al*. 2018; Hjelset *et al.* 1999; Fedoseev 1965), and during winter bearded seals are expected 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. Further, bearded seals are not known to dive as deep as 800 m to forage (Boveng and Cameron, 2013; Cameron and Boveng 2009; Cameron *et al*. 2010; Gjertz *et al*. 2000; Kovacs 2002). Therefore, the impacts of in-water vessel and vehicle strike on bearded seals are not further analyzed. The potential effects on invertebrates, fish, and marine mammals are provided below.

4.2.3.1 Invertebrates

Vessels and in-water vehicles have the potential to harm marine invertebrates by disturbing the water column or directly striking organisms (Bishop 2008). Vessel movement may result in short-term and localized disturbances to invertebrates, such as zooplankton and cephalopods, utilizing the upper water column. Propeller wash (water displaced by propellers used for propulsion) from vessel and vehicle movement can potentially disturb marine invertebrates in the water column and are a likely cause of zooplankton mortality (Bickel et al. 2011). Since most of the macro-invertebrates within the Study Area are benthic and the Proposed Action takes place within the water column, potential for macro-invertebrate vessel or vehicle strike is extremely low. No measurable effects on invertebrate populations in the water column would occur because the number of organisms exposed to vessel movement would be low relative to total invertebrate biomass.

Under Alternatives 1 and 2, the potential for in-water vessel and vehicle strike would be the same, as there would be no additional in-water vessels or vehicles associated with the Beta camp activities. Potential disturbance or strike would occur due to submarines and UUVs operating for up to 12 hours per day over a few weeks; no measureable effect on invertebrate populations would occur because of the few individuals potentially impacted relative to the total invertebrate biomass in the region.

4.2.3.2 Fish

Fish species within the Study Area are distributed throughout the surface, water column, and seafloor. Seafloor species would not come into contact with in-water vessels and vehicles, as the maximum depth that unmanned underwater vehicles would reach is 800 m, while the water depth in the Study Area is 3,000 to 4,000 m. Arctic cod would be exposed to in-water vessels and vehicles, as their distribution within the water column is from the surface to 400 m, as discussed in Section 3.2.4.

The potential for fish to be struck by in-water vessels or vehicles from the Proposed Action would be extremely low because most fish can detect and avoid vessel and in-water device movements. Fish would not be impacted by any wave produced by a vessel in motion. As a vehicle approaches a fish, the fish could have a behavioral or physiological response (e.g., swimming away and increased heart rate) as the passing vehicle displaces them. Potential harm from exposure to vessels, vehicles, and devices is not expected to result in substantial changes to an individual's overall behavior patterns, or species fitness and recruitment, and is not expected to result in any harm at the population-level. Any isolated cases of vessels or vehicles striking an individual could injure that individual, impacting its fitness, but not to the extent that there would be harm to the viability of populations based on the small number of vessels involved, the relative short duration of the event (both in a given day and the overall length of ICEX), and fish normal response of avoiding vessels and in-water devices.

Under Alternatives 1 and 2, the potential for in-water vessel and vehicle strike would be the same, as there would be no additional in-water vessels or vehicles associated with the Beta camp activities. Potential disturbance and strike would occur due to submarines and UUVs operating for up to 12 hours per day over a few weeks. The use of in-water vessels and vehicles may result in short-term and local displacement of fishes in the water column; however, these behavioral reactions are not expected to result in substantial changes to an individual's fitness, or species recruitment, and are not expected to result in any harm at the population level. Isolated cases of vessel strike would potentially injure individuals, but would not result in population level effects.

4.2.3.3 Mammals (Marine)

Marine mammals react to vessels in a variety of ways. Some respond by retreating or engaging in antagonistic responses, while other animals ignore the stimulus altogether (Terhune and Verboom 1999; Watkins 1986). The size of a vessel and speed of travel may 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). Depths at which submarines and unmanned underwater vehicles would operate would overlap with known dive depths of ringed seals, which have been recorded to 300 m in depth (Gjertz et al. 2000; Lydersen 1991). For most of the training and testing activities during the Proposed Action vessel and vehicle speeds would not typically exceed 10 knots during the time spent within the Study Area, which would greatly lessen the likelihood of collisions with marine mammals. Submarines and unmanned underwater vehicles are not expected to elicit an anti-predator response in a ringed seal. The only predator that would be in the Study Area during the Proposed Action would be the polar bear. Since the Proposed Action would be in an area where there are no gaps or leads in the ice, polar bears would not be swimming within the water column. Submarines are much larger than the natural predators to the ringed seal, and it would not be likely that a submarine would be mistaken for polar bear and cause a ringed seal to have an anti-predator response. Although unmanned underwater vehicles are much smaller than a submarine (and are closer in size to a polar bear, or smaller), the movement patterns of these vehicles would not resemble the swimming pattern of a polar bear, and therefore would not likely result in an anti-predator reaction.

Few authors have specifically described the responses of pinnipeds to vessels, and most of the available information on reactions to boats concerns pinnipeds hauled out on land or ice. No information is available on potential responses to underwater vehicles. Brueggeman et al. (1992) stated ringed seals hauled out on the ice showed short-term escape reactions when they were within 0.25–0.5 km from a vessel. A review of seal stranding data from Alaska found that during 2014, 13 bearded seal and 10 ringed seal strandings were recorded by the Alaska Marine Mammal Stranding Network. Within the Arctic region of Alaska, 13 bearded seal and 6 ringed seal strandings were recorded. Of the 23 strandings reported in Alaska (all regions included), none were found to be caused by vessel collisions (Savage 2014). As explained earlier, bearded seals have a low probability of being encountered in the study area based on their seasonal movements to the Bering Sea during the winter season.

The chance of a vessel or in-water vehicle striking a polar bear is negligible. Polar bears, at the time of year during which the Proposed Action would occur, are found on the ice stalking breathing holes, or within their maternal dens, and are not expected to be in the water column. Therefore, no potential exists for a polar bear to be struck by a vessel or in-water vehicle.

Under Alternatives 1 and 2, the potential for in-water vessel and vehicle strike would be the same, as there would be no additional in-water vessels or vehicles associated with the Beta camp activities. The potential for vessel strike would be limited to submarines. For the reasons discussed above, it is unlikely that ringed seals would be exposed to in-water vessel strike. Movement of submarines would likely elicit a response to avoid the vessel, therefore, under the ESA, vessel movement may affect, but is not likely to adversely affect, ringed seals. Because polar bears would not be within the water column in the vicinity of the Study Area during the Proposed Action, in-water vessel strike to polar bears is not expected. Therefore under ESA, there would be no effect to polar bears from in-water vessel strike. Because any reaction to vessel movement would be temporary and would not result in behavioral patterns being significantly altered or abandoned, in-water vessel movement would not result in takes of marine mammals, including ringed seals, under the MMPA.

4.2.4 Human Presence

The ice camp established as part of the Proposed Action would consist of a dining facility, berthing units, outhouse, a runway, and heliport (Figure 2-3). Throughout the Proposed Action only essential personnel would be present at the ice camp since the Proposed Action is focused on having a small footprint on the physical and biological environment. All waste other than graywater and reverse osmosis reject water would either be removed at the end of the exercise by hauling it back to land for proper disposal. In addition to the ice camp, various personnel/equipment proficiency activities introduce additional potential human stressors, including adjacent berthing areas, human presence under water, and the potential for air-dropping equipment from military aircraft. Air-drop of equipment includes the use of a parachute and extensive packing material to reduce the speed of the package prior landing on the ice, and to reduce the likelihood of damage to the equipment from impact.

The predominant stressor that could impact marine habitats during the Proposed Action is the ice camp, from which up to 2,925 gallons of graywater and 8,064 gallons of reject water from the reverse osmosis system could be discharged. Though solid debris would be removed from this water before it is released into the Beaufort Sea, water would contain some food particles smaller than 0.16 cm (the size of the mesh screen to capture solid food debris) as well as dishwashing detergent and hand soap. The need for washing dishes would be minimal since there will be minimum food prep as freeze dried meals will be the primary meal source, supplemented by fresh produce. Ration packaging and utensils would be disposed of in the ice camp's solid waste containers. This detergent and hand soap would meet the U.S. Environmental Protection Agency's Safer Choices standards. Safer Choice standards include, but are not limited to the following requirements: (1) products must not contain chemicals included on the Toxics Release Inventory chemical list, (2) products must not be categorized as an irritant under the Office of Pesticide Program, (3) product pH must be greater than or equal to 4 and less than or equal to 9.5, (5) products cannot contain chemicals listed as carcinogens, mutagens, or reproductive or developmental toxicants, and (6) products must not contain toxic elements such as heavy metals. Dish soap used during the Proposed Action, therefore would be biodegradable and chlorine- and phosphate-free. While graywater would be discharged in the Beaufort Sea, it would dissipate quickly due to the surrounding currents. The Navy has obtained a National Pollutant Discharge Elimination System permit, from the U.S. Environmental Protection Agency, for the discharge of graywater and reverse osmosis reject water to the Beaufort Sea.

The potential 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. Although ruptured fuel drums are rare during air-drop operations, the potential risk does exist. Therefore, 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. Risks associated with the air-drop of equipment include direct strike on an animal, and the potential rupture of fuel drums in the event a parachute does not open.

Although all of the research activities have some sort of human involvement, only those activities that directly include humans in the activity (e.g., paratroopers and divers) are analyzed herein. Personnel operating unmanned vehicles, for example, would have such negligible impacts (e.g., operating the vehicle from a control room) that they are not discussed further.

Human presence has the potential to affect marine habitats (e.g., water quality), marine vegetation, and Essential Fish Habitat through the discharge of graywater and reverse osmosis reject water, and mammals through disturbance or displacement by humans. Bearded seals would not be located near the ice camp proposed action area during the course of the exercise. Therefore, the impacts of human presence on bearded seals are not further analyzed. Since there would be no effect to invertebrates, birds, and fish from human presence, these resources are not discussed further.

4.2.4.1 Marine Habitats (Water Quality)

Potential harm to marine habitats from human presence would be from the graywater and reverse osmosis reject water discharges, which would be similar under both Action Alternatives.

The information available on the potential effects from graywater discharge on the environment includes more sources of graywater than only a galley sink. Most analyses, for example, also include the discharge from showers and laundry facilities, neither of which would be present during the Proposed Action. Graywater can contain highly biodegradable organics, oil and grease, and detergent residuals (U.S. Environmental Protection Agency 1999). The constituents that food waste would contribute to graywater include oxygen demand (biochemical oxygen demand and chemical oxygen demand), nutrients, and oil and grease. The U.S. Environmental Protection Agency has calculated weighted averages for contaminant concentrations in graywater that includes shower and laundry facilities. The contaminants include biochemical oxygen demand contributions of 1,097.8 milligrams per gallon (mg/gallon), oil and grease contributions of 620.8 mg/gallon, phosphate contributions of 23.5 mg/gallon, nitrate contributions of 12.11 mg/gallon, and ammonia contributions of 387.25 mg/gallon (U.S. Environmental Protection Agency 1999). The graywater discharged from the ice camp, however, would result in much fewer contaminants, as shower and laundry facilities are not available. These parameters would be expected to cause localized water quality effects, but these would be acute and temporary, and would therefore not make any significant impacts to the overall water quality of the Study Area.

As demonstrated in Section 3.1.2, currents in the Arctic would lead to a fairly rapid mixing of graywater and reverse osmosis reject water into the environment, diluting the contaminants and high salinity water into the environment relatively quickly.

The reject water from the reverse osmosis unit would contain all of the salt from the input stream, but with less water to dilute it. The reverse osmosis unit is expected to function at 33 percent efficiency (33 percent of the input stream would be returned as potable water) based on specifications for the unit; the resulting reject water would have a salinity three times that of the input. With a higher salinity, this water would be denser than the Beaufort Sea surface waters to which it would be added, and therefore would sink into the deep ocean waters. Though the rejected water would be warmer than that of the surrounding ocean, the higher temperature would not alter the trajectory of the sinking dense reject water. Assuming the reverse osmosis unit works as expected, a maximum capacity of 288 gallons per day would be rejected into the Beaufort Sea; the total amount of reject water over the course of ICEX would be 8,064 gallons. The rejection of this high salinity water would have minimal impacts on the overall environment since it is such a miniscule percentage of the overall Beaufort Sea waters. As this dense water reaches the deep bottom layers of the Beaufort Sea, it would become part of the deep sea currents and would disperse throughout the environment (Rainville et al. 2011; Thurman and Trujillo 1997). Because of the currents in the Beaufort Sea and the limited amount of discharge, the localized increase in salinity would be short-term, temporary, and would not result in harm to water quality.

Human presence resulting from both Alternatives 1 and 2 would result in the discharge of graywater and reverse osmosis reject water to the water column. There is the potential for additional reverse osmosis reject water to be discharged in the ice camp study area if the Beta camp is constructed on the ice. No reverse osmosis would be required if the Beta camp is constructed on an inland lake. The short duration and relatively small release, however, would not have negative impacts on water quality of the Beaufort Sea.

4.2.4.2 Essential Fish Habitat

The only potential impact to Essential Fish Habitat from human presence would be from the graywater and reverse osmosis reject water discharges. The discharge of soapy dishwater and small food particles could cause acute, localized harm to water quality (see Section 4.2.4.1). Small releases would occur on a daily basis, primarily around meal times, with approximately 2,925 gallons of graywater released over the course of the Proposed Action. Graywater can contain highly biodegradable organics, oil and grease, and detergent residuals (U.S. Environmental Protection Agency 1999). The temporary and localized increase in nutrients could result in an increase in phytoplankton in the immediate vicinity of the ice camp. When excess nutrients are discharged into the environment and are consumed, the algae population will increase and then die off and the remains are consumed by bacteria. Bacterial consumption can cause dissolved oxygen in the water to decrease (Boesch et al. 1997). However, current velocity in the Beaufort Sea under the ice is typically between 0 and 10 centimeters/second (O'Brien et al. 2013), which would cause mixing and prevent the accumulation of nutrients. Although a minor increase in nutrients would occur in the immediate vicinity of the discharge pipe during the time of the discharge, it would not result in an increase in harmful algal blooms that could deprive Arctic cod and other organisms of oxygen within the Essential Fish Habitat. The likelihood of the formation of algal blooms is further reduced by the nature of the cold waters of the Arctic which would limit algal growth. Degradation of the water quality of the Study Area is especially unlikely, given the use of phosphate-free dish detergent and hand soap, as well as the relatively small amount of graywater flowing from the discharge outlet compared to the large Essential Fish Habitat area in consideration. Additionally, the use of freeze-dried meals would reduce the amount of dishwashing needed at the ice camp, since meal prep will not be required and the packaging and utensils would be disposed of in the camp's solid waste containers.

The reject water from the reverse osmosis unit would contain all of the salt from the input stream, but with less water to dilute it. Because of the currents in the Beaufort Sea and the limited amount of discharge, the localized increase in salinity would be temporary and would not result in secondary impacts to Arctic cod. Harm from the reverse osmosis discharge to the quality of the marine environment has been previously discussed in Section 4.2.4.1.

Human presence resulting from both Alternatives 1 and 2 would result in the discharge in graywater and reverse osmosis reject water to the water column. There is the potential for additional reverse osmosis reject water to be discharged in the ice camp study area if the Beta camp is constructed on the ice. No reverse osmosis would be required if the Beta camp is constructed on an inland lake. Graywater and reverse osmosis reject water discharge would result in a localized and temporary increase in oxygen demand, nutrients, and oil and grease. The short duration and relatively small release, however, would not have negative impacts on Essential Fish Habitat.

4.2.4.3 Mammals (Marine and Terrestrial)

All marine and terrestrial mammals that could occur within the vicinity of the ice camp could be behaviorally affected by the activities of setting up and dismantling the camp, and the human presence at the ice camp. Ringed seals within subnivean lairs or hauled out on the ice could be displaced if they are in the vicinity of the ice camp. (Displacement of seals is unlikely, however, due to the low average density of structures (the average ringed seal ice structure density in the vicinity of Prudhoe Bay, Alaska is 1.58 structures per km2 (Table 3 of the notice of the proposed IHA; 86 FR 70451, December 10, 2021)), lack of previous ringed seal observations on the ice during ICEX activities, and construction of the ice camp on first-year or multiyear ice without pressure ridges and deep snow drifts.) Polar bears and Arctic foxes would either be drawn to the human presence (e.g., food scraps, and curiosity of humans and objects), or would avoid the area completely, due to noise and general disruption of the area.

The essential features associated with what was previously proposed as ringed seal critical habitat that could be affected by the Proposed Action are sea ice (effects from ice camp construction and air-drop of equipment and materials) and primary prey resources (effects from graywater discharge on fish). Two types of sea ice are important to ringed seals: sea ice habitat suitable for the formation and maintenance of subnivean birth lairs used for sheltering pups during whelping and nursing, and sea ice habitat suitable as a platform for basking and molting. Since ringed seals will not be basking or molting at the time of year ICEX is occurring, only sea ice suitable for the formation of subnivean lairs is analyzed for potential harm.

The construction of the ice camp and subsequent conduct of submarine training and testing and research activities requires the boring or melting of holes through the ice to deploy equipment. The ice camp would be constructed in an area without open leads or cracks, as well as away from pressure ridges where subnivean lairs would most likely occur. Although small areas of sea ice would be disturbed, the Proposed Action would not result in large-scale or long-term modification of sea ice that would be suitable for the formation and maintenance of subnivean lairs. The size of the completed camp would be approximately 1.6 km^2 in diameter, which would not impede polar bear movement in the area.

The U.S. Geological Survey has cataloged polar bear den locations in the Beaufort Sea and from the past surveys though there have been multiple dens identified within the Study Area (Figure 3-6), the density is lower than closer to the coast. Additional dens near or within the Study Area could occur since ice and snow varies from year to year within the Arctic. Polar bear dens on ice occur along pressure ridges (which are avoided as a location for establishing the ice camp). Pregnant bears typically enter dens in November, and generally emerge from dens between the end of March and the beginning April in the Beaufort Sea (Amstrup and Gardner 1994). Reactions of female polar bears to nearby disturbance have varied; responses to aircraft and on-ice vehicle noise are provided in Sections 4.1.1 and 4.1.2, respectively. The reactions of three bears after exposure to oil field operations have been described by Amstrup (1993). In each of these instances, no behavioral response (e.g., den abandonment) was observed as a result of the continuous noise from vehicle traffic, human activity, and associated noises. In one instance, a heavily used ice road passed within 400 m in front of a den, with the bear tolerating the nearness of the activity (Amstrup 1993). The presence of the ice camp is not likely to result in abandonment of a den by a polar bear; noise and vibrations from human activity would likely be greatly attenuated by snow and ice, such that a polar bear may not feel any vibrations from the activity (Blix and Lentfer 1992). The establishment of the ice camp would not require heavy construction activities; the majority of the shelters are tents, with only a few wooden structures requiring on-ice construction. Construction activities would occur only during the first few days of camp and would not involve heavy machinery typical of construction sites. Similarly, demobilization would not require heavy demolition, as the tents are portable and relatively easily packed up and removed. The Proposed Action would be temporary and occur near the end of the denning season and away from any pressure ridges in the ice; as such, any disturbance would likely be far enough away from a den as to be unlikely to result in abandonment of the den.

Polar bears and Arctic foxes are known to be attracted to human trash (Pamperin 2008), and may be attracted to the ice camp in search of an easy food source. Polar bears have also shown high plasticity in their diet and would exploit abundant resources within their range (Clarkson and Stirling 1994; Gormezano and Rockwell 2013a, 2013b). Polar bears are also curious and have been observed investigating unfamiliar objects and smells (Stirling 1988), which has led to polar bears ingesting trash and hazardous materials including plastic, styrofoam, lead car battery, anti-freeze, and rhodamine B used as a runway marker (Amstrup 1989; Derocher and Stirling 1991; Lunn and Stirling 1985; Russell 1975). Since most food preparation, storing, and consumption of food would be within the structures of the camp it would minimize the distance from which Arctic foxes and polar bears could smell the food. The only food scraps that would not be contained within the camp and removed at the end of the Proposed Action are food scraps that are less than 1/16 in (0.16 cm) which would be discarded with the graywater. Since graywater would be discharged underneath the ice, polar bears would not come in direct contact with the discharge, as they are expected to remain on the ice, not swimming beneath it, during this timeframe of the Proposed Action. All hazardous materials would be stored within buildings at the ice camp and therefore would not be encountered by polar bears or Arctic foxes.

All air-drop of materials would include the use of a parachute 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 shelters, food, vehicles, and fuel. Two potential effects could occur from the air-drop of material: direct strike to a mammal from the dropped equipment, and rupture of the load (e.g., fuel or other material) during impact. The air-drop of equipment would occur in close proximity to the ice camp, as transporting the material to the camp from long distances would be logistically infeasible. As the ice camp site would be selected to avoid open leads and cracks in the ice, as well as pressure ridges (which would inhibit runway construction), and due to the large size of polar bears home ranges (average 149,000 km^2) (Amstrup et al. 2000) the likelihood of a polar bear occurring in the vicinity of the ice camp would be low, and the likelihood of air-dropped equipment and material landing on a polar bear even lower.

Additionally, the implementation of standard operating procedures requires that the drop location would be visually cleared of any obstructions prior to release. The drop location would also be visually cleared of any animals located on the ice prior to release, reducing the potential for direct strike. The second potential effect would be from the rupture of a load (e.g., fuel drums or other material) upon impact with the ice. Assuming a worst case scenario occurs in that a parachute fails to open for a load of fuel (five 55-gallon drums), the potential for 275 gallons of fuel to be released to the ice could occur. The likelihood of this occurring is extremely remote; the military frequently drops equipment and material (including fuel) to support operations and humanitarian aid and, although ruptures have occurred, they are very infrequent. Even in the case of a parachute failure, typically only one or two barrels would be dented or 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 or contain spilled fuel from the ice floe. All snow and ice cover that would become contaminated by fuel spill would be collected and removed from the ice floe to the greatest extent possible. 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. The majority of refueling operations would be conducted within secondary containment, thus greatly reducing the likelihood that a mammal would encounter these spills. The landing zone would be visually cleared prior to the air drop or refueling, this would ensure that a polar bear, ringed seal, or Arctic fox would not likely be on the ice floe in the area of a potential spill.

Reports of hauled out ringed seals (during late spring) indicate that they may avoid human presence at distances greater than 200 m (Smith and Hammill 1981). In these instances, the seals returned to the water from their haul-out position, based on apparently smelling the human observer. The construction of the ice camp and associated human presence could potentially cause ringed seals to leave an established lair or breathing hole. Displacement of seals is unlikely, however, due to the low average density of structures (the average ringed seal ice structure density in the vicinity of Prudhoe Bay, Alaska is 1.58 structures per km^2 (Table 3 of the notice of the proposed IHA; 86 FR 70451, December 10, 2021)), lack of previous ringed seal observations on the ice during ICEX activities, and construction of the ice camp on first-year or multiyear ice without pressure ridges and deep snow drifts.

Ringed seals create subnivean lairs within the large snow drifts on the ice in the Beaufort Sea. Snow depths of at least 50–65 cm are required for functional birth lairs (Kelly 1988a; Lydersen 1998; Lydersen and Gjertz 1986; Smith and Stirling 1975), and such depths typically are found only where 20–30 cm or more of snow has accumulated on flat ice and then drifted along pressure ridges or ice hummocks (Hammill 2008; Lydersen et al. 1990; Lydersen and Ryg 1991; Smith and Lydersen 1991). 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. Even if ringed seals abandoned 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). However, as previously discussed, the ice camp location would be selected, in part, to avoid areas near pressure ridges where ringed seals may build their subnivean lairs, and any evacuation or abandonment of lairs or breathing holes is unlikely. Additionally, construction of the ice camp would be completed prior to mid-March when ringed seal whelping occurs in the Arctic. As such, and considering that ringed seal lairs are not expected to occur in the ice camp area for the reasons stated above in this section, pups are not anticipated to be in the vicinity of the camp, and mothers would not need to move newborn pups due to construction of the camp. Ringed seals have a strong fidelity to under-ice home ranges; disturbance in the area around one breathing hole may result in ringed seals needing to expend more energy to arrive at other breathing holes in the area, depending on the location of the seal in relation to the activity (Kelly et al. 2010). While relocating to a different breathing hole could change predation risk, such a risk is scenario-specific and speculative, and is not possible to determine such risk.

Human presence could potentially affect marine mammals within the water column during diving evolutions as part of the research objectives to measure personnel and equipment proficiency. 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 marine mammals in the immediate area of the diving activity, but given the expected density of ringed seals, and the lack of ringed seal observations during previous ICEX activities, disturbance of ringed seals due to human presence is unlikely.

In determining the potential effects of the graywater discharge, Navy analyzed research on currents and gyres. Plueddemann et al. (1998) used an Ice-Ocean Environmental Buoy frozen into Arctic pack ice approximately 241 km north of Prudhoe Bay, Alaska, to obtain long-term measurements of meteorological and oceanographic variables in the Arctic. This buoy travelled within the vicinity of the Study Area for the first few months prior to moving into the Chukchi Sea. This study concluded that the ice drift within the Beaufort Gyre ranged from approximately 1 to 5 cm/s (Plueddemann et al. 1998). Ice Ocean Environmental Buoy deployment within the Beaufort Gyre has also been used to study various physical properties of Arctic eddies. A recent study by O'Brien et al (2013) used moorings with sequential sediment traps to study downward sediment flux in the Canada Basin. These sediment traps measured water current speed at multiple depths, finding that from the surface to 83 m, velocities were typically between 0 and 10 cm/s, though could increase to 40 cm/s in the event of encounter with an eddy.

Direct effects from the graywater discharge on ringed seals are unlikely, as the potential for a ringed seal to be in the vicinity of the discharge pipe during graywater discharged is minimal, given the propensity for ringed seals to avoid human presence and the location of the discharge near the center of the ice camp (rather than on the periphery or away from the camp) (Smith and Hammill 1981). However, the discharge of graywater may cause minor secondary effects to the surrounding water and therefore potentially prey species. Effects to the surrounding water are discussed in Section 4.2.4.1, and the effects to prey species are discussed in Section 4.2.4.2. The most likely potential effects to proposed critical habitat would be from the graywater and reverse osmosis reject water discharges and potential effects to primary prey resources. As discussed above for secondary effects to ringed seals, the graywater discharge would result in minor and temporary increases in nutrients in the immediate vicinity of the discharge location. Similarly, the reject water would result in minor and temporary increases in salinity and temperature in the immediate vicinity of the discharge location. However, currents within the Beaufort Sea would rapidly disperse the discharges, eliminating the possibility of eutrophication. An increase in nutrients from the graywater discharge would not result in potentially harmful algal blooms. Because of the currents in the Beaufort Sea and the limited amount of discharge, the localized increase in nutrients and salinity would not result in damaging algal blooms that could deprive fish (including cod, a primary prey of the ringed seal) and other organisms of oxygen. Therefore, prey availability would not be reduced.

Under Alternative 1, human presence would include the ice camp and its associated graywater discharge, reverse osmosis reject water discharge, divers under the ice, and various personnel conducting research activities on and under the ice. The potential for impact would be minor given the low likelihood that a seal would come in contact with a human in the water. Even if an encounter were to occur, any behavioral response by the seal would be short-term and minor. Ringed seals could be disturbed by the establishment of the ice camp; therefore, under ESA, Alternative 1 may affect, but not likely to adversely affect, ringed seals. Polar bears may be attracted to the ice camp due to food smells and the novelty of the human presence. As such under ESA, Alternative 1 may affect, but not likely to adversely affect, polar bears. Any effects to marine mammals (ringed seals, and polar bears) would be minimal and temporary (where behavioral patterns would not be significantly altered or abandoned), and therefore would not result in takes of marine mammals under MMPA or ESA.

Under Alternative 2, human presence would include the same elements as under Alternative 1, with the additional Beta camp and reverse osmosis reject water discharge biennially. The location of the Beta camp, if constructed in Deadhorse, would be in a commercial area near lodging facilities, and the presence of polar bears in the area would be rare. Potential effects associated with the ice camp under Alternative 2 would be the same as Alternative 1. Therefore under ESA, human presence may affect, but not likely to adversely affect, ringed seals and polar bears. Any effects to marine mammals (ringed seals, and polar bears) would be minimal and short-term, and would not result in takes of marine mammals under MMPA or ESA.

4.3 Expended Materials

The expended material stressors include combustive byproducts and entanglement. Military expended material, such as EMATTs are not described further due to the negligible impact to bottom substrate in the deep arctic basin they would have. The small number of EMATTs used during research activities (4), the small size of an EMATT (4 inches in diameter by 36 inches long tubular shape) and the unknown final scuttle location within the deep arctic basin create negligible impacts from the EMATT compared to the size of the area. EMATTs would quickly fall into the sediment once they have scuttled and become incorporated into the seafloor. Additionally, these items would not be ingested by marine mammals or fish. These items would be too large for a fish to ingest, due to the rapid sinking after the EMATT scuttles; it would be incorporated into the deep arctic basin which is beyond the feeding depth for marine mammals in the area. Therefore, bottom disturbance and ingestion stressors will not be discussed further in this section.

4.3.1 Combustive Byproducts

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 µg/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 µg/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, Achromobacte*r, and *Arthrobacter*) attack and ultimately process Otto Fuel II, thereby removing trace amounts that may remain (Drzyzga and Blotevogel 1997; Powell et al. 1998; Sun et al. 1996; U.S. Department of the Navy 1997; Walker and Kaplan 1992).

Combustive byproducts would only be released in the water column and would dissipate quickly. Therefore, it would not affect any marine vegetation, or marine birds and they would not be further discussed. Additionally, as described in Section 4.2.34-26, bearded seals are not expected to occur near the ice camp or where the submarine activities, including torpedo exercises, will be conducted during the timeframe of the Proposed Action. Therefore, the impacts of combustive byproducts on bearded seals are not further analyzed. The potential effects on marine habitats (water quality), Essential Fish Habitat, invertebrates, fish, and marine mammals are provided below.

4.3.1.1 Marine Habitat

Approximately 30,000 exercise tests of the MK 48 torpedo have been conducted over the last 25 years. Most of these launches have been on Navy test ranges, where there have been no reports of harmful impacts on water quality from Otto Fuel II or its combustion products. Furthermore, U.S. Navy studies conducted at torpedo test ranges that have lower flushing rates than the open ocean did not detect residual Otto Fuel II in the marine environment (U.S. Department of the Navy 1996).

For properly functioning torpedoes, chemical, physical, or biological changes to sediment or water quality would not be detectable and would be below or within existing conditions. Impacts would be minimal for the following reasons: (1) the size of the area in which expended materials would be distributed is large; (2) the majority of propellant combustion byproducts are benign, while those of concern would be diluted to below detectable levels within a short time; (3) most propellants are consumed during normal operations; (4) the failure rate is low for such expended materials; and (5) most of the constituents of concern are biodegradable by various marine organisms or by physical and chemical processes common in marine ecosystems.

For lost or malfunctioning torpedoes, chemical, physical, or biological changes to sediment or water quality would not be detectable and would be below or within existing conditions. Impacts would be minimal for the following reasons: (1) the size of the area in which expended materials would be distributed is large; (2) the majority of propellants (99 percent) are consumed during normal operations and the failure rate is low, so quantities of unused propellants would be low;

and (3) studies indicate that most of the constituents of concern are biodegradable by various marine organisms or by physical and chemical processes common in marine ecosystems.

Under Alternatives 1 and 2, potential impacts due to combustive byproducts and Otto Fuel II being released into the water column from torpedoes would be the same. The relatively small release and quick dilution into the water column however, would not have negative impacts on water quality of the Beaufort Sea. As TORPEXs would occur every four years, release of combustive byproducts and Otto Fuel II would also only occur every four years.

4.3.1.2 Invertebrates

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 marine invertebrates because the chemicals have relatively low toxicity. Marine invertebrates may be exposed by contact with the chemical, contact with chemical contaminants in the sediment or water, and ingestion of contaminated sediments. These situations typically include rapid dilution, and doses large enough to have detectable effects are uncommon in most circumstances. Additionally, direct ingestion of chemicals expended from the torpedoes by an invertebrate is unlikely.

Under Alternatives 1 and 2, potential impacts due to combustive byproducts and Otto Fuel II being released into the water column from torpedoes would be the same. Although potential ingestion of Otto Fuel II and other combustion byproducts may occur, no measureable effect on invertebrate populations would occur due to the low amount of combustion byproducts discharged, and that the number of potentially affected invertebrates would be low relative to total invertebrate biomass.

4.3.1.3 Fish

Potential harm to fish from the release of combustion byproducts would be governed by the amount of harmful substances remaining in the water following the torpedo run. Fish can readily vacate the area and are less susceptible to potential harm from chemical releases. Additionally, chemical byproducts will rapidly disperse in the seawater.

Under Alternatives 1 and 2, potential impacts due to combustive byproducts and Otto Fuel II being released into the water column from torpedoes would be the same. Although potential ingestion of combustion byproducts or Otto Fuel II may occur, no measureable effect on fish populations would occur due to the low amount discharged.

4.3.1.4 Essential Fish Habitat

The only potential impact to Essential Fish Habitat from combustive byproducts would be from the chemicals released into the water column from the torpedoes. There have been no reports of harmful impacts on water quality from Otto Fuel II or its combustion products used in previous torpedo launches. Currents in the Arctic would lead to a fairly rapid mixing of released Otto Fuel II or the combustive byproducts from the torpedo into the environment, diluting the contaminants into the environment relatively quickly.

As stated in Section 4.3.1.1 above for properly functioning materials, chemical, physical, or biological changes to sediment or water quality would not be detectable and would be below or within existing conditions or designated uses. Impacts would be minimal for the following reasons: (1) the size of the area in which expended materials would be distributed is large; (2) the majority of propellant combustion byproducts are benign, while those of concern would be diluted to below detectable levels within a short time; (3) most propellants are consumed during normal operations; (4) the failure rate is low for such expended materials; and (5) most of the constituents of concern are biodegradable by various marine organisms or by physical and chemical processes common in marine ecosystems.

Under Alternatives 1 and 2, potential impacts due to combustive byproducts and Otto Fuel II being released into the water column from torpedoes would be the same. Combustion byproducts associated with Alternative 1and 2 would not significantly reduce the quantity or quality of Essential Fish Habitat. The quality of Essential Fish Habitat would only be temporarily reduced, as physical, chemical, or biological properties of the water would not be altered to a degree where it could be meaningfully measured or observed at the completion of the event. Additionally, combustion byproducts would not result in a potential loss of or injury to either prey species or their habitat. The short duration and relatively small release, however, would not have negative impacts on Essential Fish Habitat.

4.3.1.5 Marine Mammals

Potential harm to marine mammals from the release of combustion products would be governed by the amount of harmful substances remaining in the water following the torpedo run. Marine mammals can readily vacate the area and are less susceptible to potential harm from chemical releases. Additionally, chemical byproducts will rapidly disperse in the seawater.

Under Alternatives 1 and 2, potential impacts due to combustive byproducts and Otto Fuel II being released into the water column from torpedoes would be the same. Stressors from chemical releases could pose indirect effects on marine animals by affecting habitat, water quality, or prey. In accordance with the ESA, combustion byproducts would have no effect on ringed seals or polar bears. In accordance with the MMPA, combustion byproducts would not result in takes of marine mammals.

4.3.2 Entanglement

Devices that pose an entanglement risk are those with lines or tethers; in-water devices (hydrophones, and acoustic arrays), and towed devices from unmanned underwater vehicles. Hydrophones are deployed to depths of 31 m, and acoustic arrays are deployed to depths of 200 m. All lines hanging from ice would be weighted, and therefore would not have any loops or slack. The final line that could be a threat for entanglement is the use of a device tethered to an unmanned underwater vehicle (depth of 91 m). The tether for this research initiative has a diameter of 8.9 millimeters, and is made of Kevlar. This tether has a very high breaking strength (1,543 lb force), but environmental resources should not be at high risk due to the small likelihood of any loops or slack developing in this line.

It is not anticipated that entanglement would affect marine habitats, vegetation, birds, terrestrial mammals, or Essential Fish Habitat, as they are not within an area to be adversely affected or cannot become entangled in expended material. Therefore, they will not be further discussed. Additionally, bearded seals would not be located near the ice camp proposed action area during the timeframe of the Proposed Action. Therefore, the impacts of entanglement with expended materials on bearded seals are not further analyzed. The potential effects on invertebrates, fish, and marine mammals are provided below.

4.3.2.1 Invertebrates

A marine invertebrate that might become entangled may only be temporarily confused and escape unharmed, it could be held tightly enough that it could be injured during its struggle to escape, it could be preyed upon while entangled, or it could starve while entangled. The likelihood of these outcomes cannot be predicted with any certainty because interactions between invertebrate species and entanglement hazards are not well known. Potential entanglement scenarios are based on observations of how marine invertebrates are entangled in marine debris that typically floats at the sea surface for long periods of time (e.g., plastic bags and food wrappers), which is far more prone to tangling than weighted sensors dangling from buoys, lines from acoustic arrays, or the tether from the unmanned underwater vehicle, because these devices would not have materials prone to developing loops (Environmental Sciences Group 2005; Ocean Conservancy 2010). Deployments of the sensors and acoustic arrays could cause short-term and localized disturbances to invertebrates utilizing the upper water column. Since most of the invertebrates within the Study Area are benthic, the risk of entanglement from deployment of sensors and arrays is extremely low.

Under Alternatives 1 and 2, the potential for entanglement would be limited to the hydrophones used for the underwater tracking range at the ice camp and the execution of research activities (such as in-water devices used for data collection). Lines extending from the hydrophones would be retrieved at the completion of the exercise. Given that most invertebrates in the Study Area are benthic, the likelihood of entanglement is extremely limited. Although the small potential exists for an individual to become entangled, no measureable effect on invertebrate populations would occur.

4.3.2.2 Fish

The likelihood of fish being affected by an entanglement stressor is a function of the physical properties, location, and buoyancy of the object, and the behavior of the fish. Most entanglement observations involve abandoned or discarded nets, lines, and other materials that form loops or incorporate rings (Derraik 2002; Keller et al. 2010; Laist 1987; Macfadyen et al. 2009). A 25-year dataset assembled by the Ocean Conservancy (2010) reported that fishing line, rope, and fishing nets accounted for approximately 68 percent of fish entanglements, with the remainder due to encounters with various items such as bottles, cans, and plastic bags.

Fish entanglement occurs most frequently at or just below the surface or in the water column where objects are suspended; however, the physical properties (taut lines with no slack) of the materials associated with ICEX are not expected to cause any entanglement. More fish species are entangled in coastal waters and the continental shelf than elsewhere in the marine environment because of higher concentrations of human activity (e.g., fishing, sources of entangling debris), higher fish abundances, and greater species diversity (Helfman et al. 2009;

Macfadyen et al. 2009). The consequences of entanglement range from temporary and inconsequential to major physiological stress or mortality.

Some fish are more susceptible to entanglement in derelict fishing gear and other marine debris, compared to other fish groups. Physical features, such as rigid or protruding snouts of some elasmobranchs (e.g., the wide heads of hammerhead sharks), increase the risk of entanglement compared to fish with smoother, more streamlined bodies (e.g., lamprey and eels). Most other fish, except for jawless fish and eels that are too smooth and slippery to become entangled, are susceptible to entanglement gear specifically designed for that purpose (e.g., gillnets); however, no items would be expended that are designed to function as entanglement objects, nor are they designed to have slack or form loops. Expended materials have the potential to strike fish as they sink to the seafloor. Although individual fish may be at some marginal risk of injury, there would be no population-level impacts from these materials, due to the dispersed nature and small amount of the expended material.

Under Alternatives 1 and 2, the potential for entanglement would be limited to the hydrophones used for the underwater tracking range at the ice camp. Lines extending from the hydrophones would be retrieved at the completion of the exercise. Entanglement of fish in the lines associated with the hydrophones are not anticipated, given the mobility of the fish and the weighted (e.g., no slack or loops) line of the hydrophone. This equipment may harm individual animals, but the number of individuals that could be harmed would be few such that it would not result in significant population-level effects.

4.3.2.3 Mammals (Marine)

The risks of entanglement would be from the lines coming off the hydrophones associated with the underwater acoustic tracking range and acoustic arrays from the in-water device data collection research activities. The hydrophones and acoustic array lines would have weights attached so no loops or slack in the lines are anticipated. Potential entanglement from the Proposed Action would only occur with vertical line arrays or hydrophones hanging down through hole which a marine mammal used to breathe. Furthermore, marine mammal occurrence is expected to be minimal within the water column during the Proposed Action.

The likelihood of a marine mammal encountering and becoming entangled in a line depends on several factors. The amount of time that the line is in the same vicinity as a marine mammal can increase the likelihood of it posing an entanglement risk. The length of the line varies (up to about 200 m), and greater lengths may increase the likelihood that a marine mammal could become entangled.

An animal would have to swim through loops or become twisted within the lines to become entangled. Ringed seals could potentially become entangled if they attempt to use a hole from which equipment is being deployed. Given that most breathing holes would already be established at this time of year, and that the likelihood that a seal would choose a hole being used for human activities is very low, the likelihood of entanglement with a line through the bored hole would be low. Furthermore, the likelihood of entanglement with a line deployed through the bored hole would be very low because the line would generally be taut and connected to the surface or underwater vehicle, and would not have slack or loops in the line.

Under Alternatives 1 and 2, the potential for entanglement would be limited to the hydrophones used for the underwater tracking range at the ice camp. Lines extending from the hydrophones would be retrieved at the completion of the exercise. Although the likelihood of entanglement remains low due to the fact that the lines would not have slack or loops, under ESA, entanglement associated with the Proposed Action, may affect, but is not likely to adversely affect, ringed seals. Because polar bears would not be within the water column during the Proposed Action, under ESA there would be no effect to polar bears. In accordance with the MMPA, any effects to marine mammals (ringed seals, and polar bears) would be minimal and temporary (where behavioral patterns would not be significantly altered or abandoned), and therefore would not result in takes of marine mammals.

4.4 SUMMARY OF ANALYSIS

The portion of the Proposed Action occurring in Prudhoe Bay would not increase the demands on resources due to an influx of personnel. Additionally, the Proposed Action would not impact subsistence hunting as hunting does not occur within the Study Area during the timeframe of the Proposed Action for bearded and ringed seals, and no mortality of ringed or bearded seals is expected or proposed to be authorized under the IHA. Although hunting for polar bears and arctic foxes does occur year-round, the Proposed Action is far outside of the normal areas hunting occurs.

The analysis provided in Chapter 3 and Chapter 4 describes how, in accordance with NEPA, the Proposed Action would not result in significant impacts to the physical or biological environment. In accordance with E.O. 12114, the Proposed Action, as analyzed above, would not cause significant harm to the human or biological environment.

CHAPTER 5 CUMULATIVE IMPACTS

This section (1) defines cumulative impacts, (2) describes past, present, and reasonably foreseeable future actions relevant to cumulative impacts, (3) analyzes the incremental interaction the Proposed Action may have with other actions, and (4) evaluates cumulative impacts potentially resulting from these interactions.

5.1 Definition of Cumulative Impacts

The approach taken in the analysis of cumulative impacts follows the objectives of National Environmental Policy Act (NEPA), Council on Environmental Quality (CEQ) regulations, and CEQ guidance. Cumulative impacts are defined as the impact on the environment that results from the incremental impact of the action when added to the other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time.

To determine the scope of environmental assessments, agencies shall consider cumulative actions, which when viewed with other proposed actions, have cumulatively significant impacts and should therefore be discussed in the same assessment.

In addition, CEQ and the USEPA have published guidance addressing implementation of cumulative impact analyses—Guidance on the Consideration of Past Actions in Cumulative Effects Analysis (Council on Environmental Quality 2005) and Consideration of Cumulative Impacts in EPA Review of NEPA Documents (United States Environmental Protection Agency 1999). CEQ guidance entitled *Considering Cumulative Impacts Under NEPA* (1997) states that cumulative impact analyses should "…determine the magnitude and significance of the environmental consequences of the proposed action in the context of the cumulative impacts of other past, present, and future actions...identify significant cumulative impacts…[and]…focus on truly meaningful impacts."

Cumulative impacts are most likely to arise when a relationship or synergism exists between a proposed action and other actions expected to occur in a similar location or during a similar time period. Actions overlapping with, or in close proximity to, the proposed action would be expected to have more potential for a larger potential for resource impacts than those more geographically separated. Similarly, relatively concurrent actions would tend to offer a higher potential for cumulative impacts. To identify cumulative impacts, the analysis needs to address the following three fundamental questions:

- Does a relationship exist such that affected resource areas of the Proposed Action might interact with the affected resource areas of past, present, or reasonably foreseeable actions?
- If one or more of the affected resource areas of the proposed action and another action could be expected to interact, would the Proposed Action affect or be affected by impacts of the other action?

- If such a relationship exists, then does an assessment reveal any potentially significant impacts not identified when the Proposed Action is considered alone?

5.2 Scope of the Cumulative Impact Analysis

The scope of the cumulative impacts analysis involves both the geographic extent of the effects and the time frame in which the effects could be expected to occur. For this EA/OEA, the study areas delimit the geographic extent of the cumulative impacts analysis for the action alternatives. The time frame for cumulative impacts centers on the timing of the Proposed Action, which will occur over a six-week period during February-April.

Another factor influencing the scope of cumulative impacts analysis involves identifying other actions to consider. Beyond determining that the geographic scope and time frame for the actions interrelate to the Proposed Action, the analysis employs the measure of “reasonably foreseeable” to include or exclude other actions. For the purposes of this analysis, public documents prepared by federal, state, and local government agencies form the primary sources of information regarding reasonably foreseeable actions.

5.2.1 Past, Present, and Reasonably Foreseeable Future Actions

In determining which projects to include in the cumulative impacts analysis, a preliminary determination was made regarding the past, present, or reasonably foreseeable future projects at or near the Study Area. Specifically, using the first fundamental question included in Section 5.1, it was determined if a relationship exists such that the affected resource areas of the Proposed Action might interact with the affected resource area of a past, present, or reasonably foreseeable action. If no such potential relationship exists, the project was not carried forward into the cumulative impacts analysis. In accordance with CEQ guidance (Council on Environmental Quality 2005), projects included in this cumulative impacts analysis are listed in Table 5-1 and briefly described in the following subsections.

Table 5-1. Recent Past, Present, and Reasonably Foreseeable Future Actions within the Vicinity of the Study Area

Action	*Agency*	*Level of NEPA and/or E.O. 12114 Analysis Completed*
Ice Exercises (ICEX)	Navy	OEA (2014, 2016, 2018, 2020)
Outer Continental Shelf Leasing Programs	BOEM	PEIS (2017-2022)
Liberty Project	BOEM	EIS in process
Arctic Research Activities	Navy ONR	OEA (2018-2022)
Canada Basin Acoustic Propagation Experiment	Navy ONR	OEA (2015, 2016)
Arctic Shield	USCG	PEA (2019)
Pipeline projects (Alaska LNG; Donlin Gold, LLC)	BLM	Future
Polar Icebreaker	USCG	PEIS 2020

ONR = Office of Naval Research; BLM = Bureau of Land Management; PEIS = Programmatic Environmental Impact Statement; USCG = United States Coast Guard; BOEM = Bureau of Energy Management

Previous activities in the deep basin of the Beaufort Sea have been limited, primarily due to ice cover. The primary federal activity off the North Slope of Alaska is oil and gas exploration and extraction. BOEM has multiple projects in the region, utilizing large swaths of the federal waters and potential leasing sites for oil and gas developers. The BOEM Beaufort Sea Planning Area extends out to over 100 nm from shore and into the Study Area, though those areas within the Canada Basin are not presently used for any oil/gas related activity. The majority of the BOEM leasing sites used by Shell are in water depths of less than 30.5 m (U.S. Department of the Interior 2013), which is likely of most other lease sites as well, due to their presence primarily on the Outer Continental Shelf. Despite a temporary stay on drilling for oil in the Arctic (E.O. 13754), oil and gas presence may increase over time as needs for fossil fuels continue to rise.

With decreasing first-year and multi-year ice, the Arctic is becoming increasingly accessible. After the Northwest Passage opened in 2007, it paved the way for an increase in maritime traffic through the region, including recent tourism cruises through the region. This increase in accessibility is likely to lead to even more activities as vessels of different sizes and icebreaking capacity are able to enter the region- leading to increases in tourism, industry, research, and military vessels. Presently, the Navy, U.S. Coast Guard, Army, and Air Force operate in the Beaufort Sea. Activities through these agencies can be based either in national defense or research. Various research activities occur in the Arctic, conducted by agencies (e.g., NOAA, USFWS), other federal entities (e.g., National Science Foundation), universities (e.g., Massachusetts Institute of Technology), as well as other nations. Any activities in the North Slope of Alaska or in the Beaufort Sea would increase air emissions; any incremental GHG contributions by these activities are likely to cumulatively contribute to climate change and decreased overall air quality.

One of the most concerning issues associated with the Arctic is climate change and the disappearing of the sea ice in the region. The National Aeronautics and Space Administration Earth Observatory has determined via satellite imagery that multi-year sea ice is persistently declining in the Arctic (Lindsey 2015). This past year has been the first year the multiyear ice has not recovered from the summer melt. This is particularly problematic for ICEX due to the concerns about finding suitable ice on which the ice camp would be built; ICEXs in 2014 and 2016 concluded early due to cracking ice around the ice camp area, leading to emergency demobilizations.

The other activities in the region, as laid out in Table 5-1, are likely to produce air emissions and noise into the surrounding environment. Ice cover increases the ambient noise underwater, and therefore increased vessel presence is unlikely to negatively impact the biological resources of the Beaufort Sea, but oil and gas drilling may. However, the ice camp study area would be at least 100 nm offshore from existing leased oil and gas areas and construction activities, and therefore noise from those activities would be unlikely to have an effect on underwater resources. Air emissions from ICEX would be produced by daily aircraft flights. Emissions would be produced at the ice camp from the use of snowmobiles, gas powered augers and saws, and diesel generators. Though the impacts to air quality from ICEX alone have been determined to have no effect on the air quality in the region, when combined with greenhouse gas emissions from other activities and actions in the Beaufort Sea, would contribute to global climate change. Atmospheric carbon dioxide levels have been steadily increasing over time; in October 2016 the global average was 402.31 parts per million, up from 398.60 parts per million in October 2015 (Dlugokencky and Tans 2017). GHGs in the atmosphere lead to higher temperatures, explaining the record high winter temperatures in the Arctic. These high temperatures have caused decreased sea ice and warmer water temperatures, which risk altering the physical environment indefinitely. These changes are likely to lead to increased risk to Arctic species, such as the polar bear, which rely on sea ice for their homes, and ringed seals, who pup in subnivean lairs within sea ice. In 2015, the average temperature across global land and ocean surfaces was 1.62 °F above the twentieth-century average; it was the hottest year in the 136-year record (Dahlman 2015).

The habitat of Arctic species has been altered by the warming climate, and scientific consensus projects continued and accelerated warming in the foreseeable future. This continued warming will decrease sea ice and snow cover that seals and polar bears rely on throughout their lifecycle. Ringed seals use sea ice for resting, whelping, and molting, while polar bears primarily use it for hunting, mating, and maternity denning. Climate change has caused a reduction in the distribution, abundance, and body condition of Arctic species. Additionally, ocean warming and acidification alter prey populations that marine mammal species rely on, and increase competition with subarctic species (Laidre et al. 2008). Although climate change is a continuing threat to Arctic species, activities conducted during ICEX will have a negligible additional impact since they are temporary, and planned mitigation measures are expected to reduce impacts to protected species during the activities.

While emissions from aircraft using the Deadhorse Airport, at Prudhoe Bay would incrementally contribute to greenhouse gases and global climate change, this increase in traffic would have negligible impacts to the actual Prudhoe Bay, Alaska area. The project is brief and temporary in nature, and therefore would not require long-term residencies by any participants. No additional facilities would need to be built; all on-shore activities would utilize those already present.

ICEX activities are short-term and conducted biannually so the risk of exposing the same animals in multiple ICEXs or ONR activities is low. Additionally because of the distance between oil and gas activities to the area where the Navy operates for ICEX and ONR testing, the risk is low in exposing the same animals to both the oil and gas activities and the Navy activities. Based on the past, present, and reasonably foreseeable future actions within the Study Area, ICEX would not be expected to considerably contribute to any cumulative impacts from all other actions and activities in the Beaufort Sea.

CHAPTER 6 STANDARD OPERATING PROCEDURES AND MITIGATION MEASURES

The Navy has identified multiple measures that would further reduce and avoid potential impacts resulting from the Proposed Action. Both standard operating procedures and mitigation measures would be implemented during the Proposed Action. Standard operating procedures serve the primary purpose of providing for safety and mission success, and are implemented regardless of their secondary benefits (e.g., to a resource), while mitigation measures are used to avoid or reduce potential impacts.

Though the Proposed Action would utilize both standard operating procedures and mitigation measures in a variety of manners, the activities using active acoustics would utilize passive acoustic listening. Submarines conducting training activities would utilize passive acoustic sensors to listen for vocalizing marine mammals, and active transmissions would be halted in the event that vocalizing marine mammals are detected.

Additional mitigations were considered for research activities, however, because those activities that result in exposures to marine mammals occur under the ice, there are no methods to visually or acoustically monitor the area, therefore no additional mitigation is feasible.

6.1 STANDARD OPERATING PROCEDURES

The following procedures would be implemented:

- The location for any air-dropped equipment and material would be visually surveyed prior to release of the equipment/material to ensure the landing zone is clear. Equipment and materials would not be released if any animal is observed within the landing zone.
- Air drop bundles would be packed within a plywood structure with honeycomb insulation to protect the material from damage.
- Spill response kits/material would be on-site prior to the air-drop of any hazardous material (e.g. fuel).

6.2 MITIGATION MEASURES

In addition to the standard operating procedures above, the following mitigation measures would be implemented to reduce or avoid potential harm to marine resources.

Measures to avoid take during on-ice activities

- The ice camp and runway would be established on multi-year ice without pressure ridges.
- Ice camp deployment would begin no later than mid-February and be gradual, with activity increasing over the first five days and must be completed by March 15, 2022. This allows ringed seals to avoid the camp area prior to pupping, further reducing potential impacts.

- Personnel on all on-ice vehicles would observe for marine and terrestrial animals
- Snowmobiles would follow established routes, when available. On-ice vehicles will not be used to follow any animal, with the exception of actively deterring polar bears if the situation requires.
- Personnel on foot and operating on-ice vehicles would avoid areas of deep snowdrifts near pressure ridges.
- Navy personnel would maintain a 100-meter (328 ft) avoidance distance from all observed marine mammals.
- On-ice vehicles would not be used to follow any animal, with the exception of actively deterring polar bears if the situation requires
- All material (e.g., tents, unused food, excess fuel) and wastes (e.g., solid waste, hazardous waste) would be removed from the ice floe upon completion of ICEX activities.

Shutdown and Delay Measures for Acoustic Activities

- Navy personnel would begin passive acoustic monitoring (PAM) 15 minutes prior to start of activities involving active acoustic transmissions from submarines and torpedoes.
- Navy personnel would delay active acoustic transmissions and launch of exercise weapons if a marine mammal is detected during pre-activity PAM and must shutdown active acoustic transmissions if a marine mammal is detected during acoustic transmissions.
- Navy personnel would not restart acoustic transmissions or launch of exercise weapon until 15 minutes have passed with no marine mammal detections.

Mitigation required for aircraft activities

- Fixed wing aircraft would 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 would not reduce altitude if a seal is observed on the ice. In general, cruising elevation would be 305 m (1000 ft) or higher.
- Unmanned Aircraft Systems (UASs) would maintain a minimum altitude of at least 15.2 m (50 ft) above the ice. They would not be used to track or follow marine mammals.

  - Helicopter flights would use prescribed transit corridors when traveling to/from Prudhoe Bay and the ice camp. Helicopters would not hover or circle above marine mammals or within 457 m (1,500 ft) of groups of marine mammals.
  - Aircraft would maintain a minimum separation distance of 1.6 km (1 mi) from groups of 5 or more seals.
  - Aircraft would not land on ice within 800 m (0.5 mi) of hauled-out seals.
- Dish and hand soap would be selected from the U.S. Environmental Protection Agency's "Safer Choice" list.
- All cooking and food consumption would occur within designated facilities to minimize attraction of nearby animals.
- All personnel will be required to complete environmental compliance training including environmental health and safety procedures.

APPENDIX A CLEAN WATER ACT PERMIT

APPENDIX B ENDANGERED SPECIES ACT CONSULTATIONS

B.1 NATIONAL MARINE FISHERIES SERVICE CONSULTATION

B.2 U.S. FISH AND WILDLIFE SERVICE CONSULTATION

APPENDIX C MARINE MAMMAL PROTECTION ACT PERMITS

C.1 PROPOSED INCIDENTAL HARASSMENT AUTHORIZATION FROM THE NATIONAL MARINE FISHERIES SERVICE

C.2 Letter of Authorization Received from the U.S. Fish and Wildlife Service

APPENDIX D SUBMARINE TRAINING AND TESTING ACTIVITIES

Details on the activities conducted by the participating submarines are classified. This appendix will be provided to authorized personnel upon request.

APPENDIX E STRESSOR MATRICES

Ten categories of stressors were identified and analyzed within this EA/OEA. A description of each stressor, including the platforms that contribute to the stressor, is provided below.

- **Acoustic Transmissions:** Includes only those active sources that produce acoustic impacts that are not considered *de minimis* and require quantitative analysis.
- **Aircraft Noise:** Includes the noise generated by manned (e.g., small twin-engine fixed wing aircraft, small rotary-wing aircraft, and large military aircraft such as the LC-130 and CH-47 Chinook helicopter) and unmanned (fixed- and rotary-wing unmanned aerial systems) aircraft.
- **On-Ice Vehicle Noise:** Includes the noise generated by the snowmobiles and small unit support vehicle.
- **Aircraft Strike:** Includes the potential for strike from both manned and unmanned aircraft.
- **On-Ice Vehicle Strike:** Includes the potential for direct contact of a snowmobile or small unit support vehicle with a resource, but also includes the potential disturbance to subnivean lairs.
- **In-water Vessel and Vehicle Strike:** Includes the potential for vessels (i.e., submarines) and vehicles (e.g., unmanned undersea vehicles) to come into direct contact with a resource.
- **Human Presence:** Although human presence would occur as part of all activities, the stressor is only included for the ice camp and for the research activities that include humans as part of the action (e.g., paratroopers and divers).
- **Combustive Byproducts:** Includes the potential for chemicals to be released into the water from exercise torpedoes.
- **Entanglement:** Includes the potential for a resource to become entangled in a temporarily-deployed device (e.g., vertical array).

Appendix Table E-1 and Appendix Table E-2 below, list applicable stressors by activity and resource.

Appendix Table E-1. Stressors by Activity

Category of Action	Project	Acoustic Stressors			Physical Stressors					
		Acoustic Transmissions	Aircraft Noise	On-Ice Vehicle Noise	Aircraft Strike	On-Ice Vehicle Strike	In-water Vessel and Vehicle Strike	Human Presence	Combustive Byproducts	Entanglement
Logistics	**Ice Camp**		X	X	X	X		X		X
Submarine Training and Testing	**Submarines**	X					X		X	
Aerial Data Collection	**Aircraft**		X	X	X	X				
In-water Device Data Collection	**Array**						X			X
Personnel/ Equipment Proficiency	**Diving**						X	X		
	Air-Drop		X	X	X	X		X		
	Aircraft		X		X					
Unmanned Aerial System Testing	**Fixed-Wing**		X		X					
	Rotary-Wing		X		X					
Unmanned Underwater Vehicle Testing	**Vehicle Testing**	X					X			X

Appendix Table E-2. Stressors by Resource

Resource		Acoustic Stressors			Physical Stressors					
		Acoustic Transmissions	Aircraft Noise	On-ice Vehicle Noise	Aircraft Strike	On-ice Vehicle Strike	In-water Vessel and Vehicle Strike	Human Presence	Combustive Byproducts	Entanglement
Water Quality								X	X	
Marine Vegetation								X		
Mammals	**Marine**	X	X	X		X	X	X	X	X
	Terrestrial		X	X		X		X		X
Marine Birds			X	X	X					
Invertebrates		X					X		X	X
Fish		X					X		X	X
Essential Fish Habitat		X						X	X	

APPENDIX F ACOUSTIC MODELING

F.1 INTRODUCTION

The marine mammal acoustics effects analysis was conducted in accordance with current Navy sonar policy, as advised by the Chief of Naval Operations Environmental Readiness Division. Accordingly, ensonified areas and exposure estimates for marine mammals were reported based on Sound Exposure Level (SEL) and Sound Pressure Level (SPL) thresholds. PTS is the criterion used to establish the onset of non-recoverable physiological effects. TTS is the criterion used to establish the onset of recoverable physiological effects, and a behavioral response function is used to determine non-physiological behavioral effects. Environmental parameters were collected and archived, and propagation modeling was performed with the Naval Oceanographic Office's Oceanographic and Atmospheric Master Library (OAML) CASS/GRAB model (Weinberg and Keenan 2008). The acoustics effects modeling utilized the databases and tools collectively referred to as the Navy Acoustic Effects Model (NAEMO) (U.S. Department of the Navy 2017c). Results were then computed for the defined operational scenario. This section provides a brief discussion of several key components of the acoustics effects modeling process, specifically: environmental inputs, acoustic sources, propagation modeling, and the NAEMO modeling software suite.

F.2 SOURCE CHARACTERISTICS AND SCENARIO DESCRIPTION

The acoustic transmissions associated with the Proposed Action fall within bins HF1 (hull-mounted submarine sonars that produce high-frequency [greater than 10 kHz but less than 200 kHz] signals) and M3 (mid-frequency [1-10 kHz] acoustic modems greater than 190 dB re 1 µPa). The parameters for the acoustic transmissions associated with research activities can be found in Table 2-2 above. Additional details about submarine training and testing and the Naval Research Laboratory source are classified can be found in the classified Appendix D.

F.3 ENVIRONMENTAL CHARACTERISTICS

Data for four environmental characteristics (bathymetry, sound speed profile, sediment characteristics, and wind speed) were obtained for the cold season to support the acoustic analysis. The databases used to obtain these data and the resulting parameters are provided in Appendix Table F-1. All of the databases are maintained by OAML.

Appendix Table F-1. Environmental Parameters for ICEX

Model / Parameter	Data Input	Database
Propagation Model	Specific data are not applicable for this parameter.	Comprehensive Acoustic System Simulation Version 4.2a
Absorption Model	Specific data are not applicable for this parameter.	Francois-Garrison (the CASS/GRAB default)
Analysis Locations	Study Area	Database not used for this parameter
Analysis Specifics	18 radials => 1 radial per 20 degrees Range increment: 50 meters Depth increment: 25 meters	Database not used for this parameter
Bathymetry	Data was obtained from a location centered around 72° 53'N, 146° 28'W. Resolution was at five hundredths (0.5) of a degree.	Digital Bathymetric Data Base Variable Resolution (DBDB-V) Version 5.4
Sound Speed Profiles	Sound speed profiles were extracted at the highest database resolution of 0.25 degree.	Generalized Digital Environmental Model Variable (GDEM-V) Version 3.0
Wind Speed	Wind speed was extracted at the highest database resolution of one (1) degree. Average wind speed: N/A for the cold season since the Study Area is ice covered	Surface Marine Gridded Climatology (SMGC) Version 2.0
Geo-Acoustic Parameters	Sediment type of sand was determined for the Study Area.	High Frequency Environmental Acoustics Version 1.1 HFEVA
Surface Reflection Coefficient Model	Specific data are not applicable for this parameter.	Navy Standard Forward Surface Loss Model

F.4 MARINE MAMMAL DENSITY ESTIMATES

Marine mammal densities utilized in the acoustic analysis were based on the best available science for the Study Area. Baseline marine mammal distribution and density data from the Navy Marine Species Density Database (NMSDD) (U.S. Department of the Navy 2017d) were first extracted for the Study Area. Datasets that comprise the NMSDD include surveys, average published population estimates, and Relative Environmental Suitability models (Kaschner et al. 2006).

F.5 CRITERIA AND THRESHOLDS

Harassment criteria for marine mammals are evaluated based on thresholds developed from observations of trained cetaceans exposed to intense underwater sound under controlled conditions (Finneran et al. 2003; Kastak and Schusterman 1996; Kastak and Schusterman 1999; Kastak et al. 2005; Kastelein et al. 2012). These data are the most applicable because they are based on controlled, tonal sound exposures within the typical sonar frequency ranges and because the species studied are closely related to the animals expected in the Study Area. Studies have reported behavioral alterations, or deviations from a subject's normal trained behavior, and exposure levels above which animals were observed to exhibit behavioral deviations (Finneran and Schlundt 2003; Schlundt et al. 2000).

Criteria and thresholds used for determining the potential effects from the Proposed Action are from NMFS technical guidance on acoustic thresholds for PTS/TTS. The behavioral criteria was developed in coordination with NMFS to support Phase III environmental analyses and MMPA Letter of Authorization renewals (U.S. Department of the Navy 2017a). Appendix Table F-2 below provides the criteria and thresholds used in this analysis for estimating quantitative acoustic exposures of marine mammals from the Proposed Action. Weighted criteria are shown in the table below. Frequency-weighting functions are used to adjust the received sound level based on the sensitivity of the animal to the frequency of the sound. For weighting function derivation, the most critical data required are TTS onset exposure levels as a function of exposure frequency. These values can be estimated from published literature by examining TTS as a function of SEL for various frequencies.

To estimate TTS onset values, only TTS data from behavioral hearing tests were used. To determine TTS onset for each subject, the amount of TTS observed after exposures with different SPLs and durations were combined to create a single TTS growth curve as a function of SEL. The use of (cumulative) SEL is a simplifying assumption to accommodate sounds of various SPLs, durations, and duty cycles. This is referred to as an “equal energy” approach, since SEL is related to the energy of the sound and this approach assumes exposures with equal SEL result in equal effects, regardless of the duration or duty cycle of the sound. It is well-known that the equal energy rule will over-estimate the effects of intermittent noise, since the quiet periods between noise exposures will allow some recovery of hearing compared to noise that is continuously present with the same total SEL (Ward 1997). For continuous exposures with the same SEL but different durations, the exposure with the longer duration will also tend to produce more TTS (Finneran et al. 2010; Kastak et al. 2007; Mooney et al. 2009).

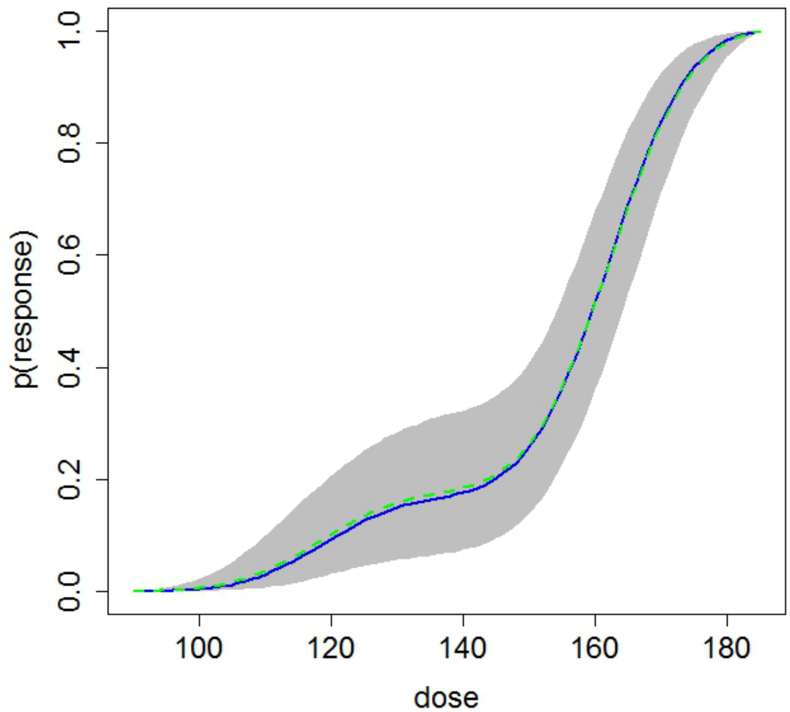
As in previous acoustic effects analysis (Finneran and Jenkins 2012; Southall et al. 2007), the shape of the PTS exposure function for each species group is assumed to be identical to the TTS exposure function for each group. A difference of 20 dB between TTS onset and PTS onset is used for all marine mammals including pinnipeds. This is based on estimates of exposure levels actually required for PTS (i.e. 40 dB of TTS) from the marine mammal TTS growth curves, which show differences if 13 to 37 dB between TTS and PTS onset in marine mammals. Details regarding these criteria and thresholds can be found in National Marine Fisheries Service (2016).

F.5.1 Behavioral Reactions or Responses

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 also 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). Reviews by Nowacek *et al.* (2007) and Southall *et al.* (2007) 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. Multi-year research efforts have conducted sonar exposure studies for odontocetes and mysticetes (Miller et al. 2012; Sivle et al. 2012). Several studies with captive animals have provided data under controlled circumstances for odontocetes and pinnipeds (Houser et al. 2013a; Houser et al. 2013b). Moretti *et al.* (2014) published a beaked whale dose-response curve based on passive acoustic monitoring of beaked whales during U.S. Navy training activity at Atlantic Underwater Test and Evaluation Center during actual Anti-Submarine Warfare exercises. This new information has necessitated the update of the Navy’s behavioral response criteria.

Southall *et al.* (2007) synthesized data from many past behavioral studies and observations to determine the likelihood of behavioral reactions at specific sound levels. While in general, the louder the sound source the more intense the behavioral response, it was clear that the proximity of a sound source and the animal's experience, motivation, and conditioning were also critical factors influencing the response (Southall et al. 2007). After examining all of the available data, the authors felt that the derivation of thresholds for behavioral response based solely on exposure level was not supported because context of the animal at the time of sound exposure was an important factor in estimating response. Nonetheless, in some conditions, consistent avoidance reactions were noted at higher sound levels depending on the marine mammal species or group allowing conclusions to be drawn. Phocid seals showed avoidance reactions at or below 190 dB re 1 μPa @1m; thus, seals may actually receive levels adequate to produce TTS before avoiding the source.

The Phase III pinniped behavioral criteria was updated based on controlled exposure experiments on the following captive animals: hooded seal, gray seal, and California sea lion (Götz et al. 2010; Houser et al. 2013a; Kvadsheim et al. 2010). Overall exposure levels were 110-170 dB re 1 μPa for hooded seals, 140-180 dB re 1 μPa for gray seals and 125-185 dB re 1 μPa for California sea lions; responses occurred at received levels ranging from 125 to 185 dB re 1 μPa. However, the means of the response data were between 159 and 170 dB re 1 μPa. Hooded seals were exposed to increasing levels of sonar until an avoidance response was observed, while the grey seals were exposed first to a single received level multiple times, then an increasing received level. Each individual California sea lion was exposed to the same received level ten times, these exposure sessions were combined into a single response value, with an overall response assumed if an animal responded in any single session. Because these data represent a dose-response type relationship between received level and a response, and because the means were all tightly clustered, the Bayesian biphasic Behavioral Response Function for pinnipeds most closely resembles a traditional sigmoidal dose-response function at the upper received levels (Appendix Figure 6-1), and has a 50% probability of response at 166 dB re 1 μPa. Additionally, to account for proximity to the source discussed above and based on the best scientific information, a conservative distance of 10 km is used beyond which exposures would not constitute a take under the military readiness definition.



Appendix Figure 6-1. The Bayesian biphasic dose-response BRF for Pinnipeds.

The blue solid line represents the Bayesian Posterior median values, the green dashed line represents the biphasic fit, and the grey represents the variance. [X-Axis: Received Level (dB re 1 µPa), Y-Axis: Probability of Response]

Appendix Table F-2. Injury (PTS) and Disturbance (TTS, Behavioral) Thresholds for Underwater Sounds.[1]

Group	Species	Behavioral Criteria	Physiological Criteria	
			Onset TTS	Onset PTS
Phocidae (in water)	Ringed seal	Pinniped Dose Response Function[2]	181 dB SEL cumulative	201 dB SEL cumulative
Ursidae (in water)	Polar bear	Pinniped Dose Response Function[2]	199 dB SEL cumulative	219 dB SEL cumulative

[1] The threshold values provided are assumed for when the source is within the animal's best hearing sensitivity. The exact threshold varies based on the overlap of the source and the frequency weighting.
[2] See Appendix Figure 6-1

F.6 NAEMO SOFTWARE

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. Inputs to the quantitative analysis included marine mammal density estimates obtained from the Navy Marine Species Density Database, marine mammal depth occurrence distributions (U.S. Department of the Navy 2017b), 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 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 Navy's standard mitigations. These databases and tools collectively form the Navy Acoustic Effects Model (NAEMO). In NAEMO, animats are distributed nonuniformly based on species-specific density, depth distribution, and group size information. 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 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. In few instances, although the activities themselves all occur within the Study Area, sound may propagate beyond the boundary of the Study Area. Any exposures occurring outside the boundary of the Study Area are counted as if they occurred within the Study Area boundary. 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 these 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:

- Animats are modeled as being underwater, stationary, and facing the source and therefore always predicted to receive the maximum sound level (i.e., no porpoising or pinnipeds' heads above water).

- 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.

- 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.

- 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.

- Mitigation measures that are implemented were not considered in the model. In reality, sound-producing activities would be reduced, stopped, or delayed 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.

For non-impulsive sources, NAEMO calculates the SPL and SEL for each active emission during an event. This is done by taking the following factors into account over the propagation paths: bathymetric relief and bottom types, sound speed, and attenuation contributors such as absorption, bottom loss and surface loss. Platforms such as a ship using one or more sound sources are modeled in accordance with relevant vehicle dynamics and time durations by moving them across an area whose size is representative of the training event's operational area. For each modeled iteration, the slow moving platform in this experiment was programmed to move along straight line tracks from a randomly selected initial location with a randomly selected course. Specular reflection was employed at the boundaries to contain the vehicle within the Study Area.

NAEMO records the SPL and SEL received by each animat within the ensonified area of the event and evaluates them in accordance with the species-specific threshold criteria. For each animat, predicted SEL effects are accumulated over the course of the event and the highest order SPL effect is determined. Each 24-hour period is independent of all others, and therefore, the same individual animat could be exposed during each independent scenario or 24-hour period. Initially, NAEMO provides the overpredicted exposures to marine species because predictions used in the model include: all animats facing the source, not accounting for horizontal avoidance and mitigation is not implemented. After the modeling results are complete they are further analyzed to produce final estimates of potential marine mammal exposures.

F.7 RESULTS

For non-impulsive sources, NAEMO calculates maximum received SPL and accumulated SEL over the entire duration of the event for each animat based on the received sound levels. These data are then processed using a bootstrapping routine to compute the number of animats exposed to SPL and SEL in 1 dB bins across all track iterations and population draws. SEL is checked during this process to ensure that all animats are grouped in either an SPL or SEL category. Additional detail on the bootstrapping process is included in Section F.7.1.

A mean number of SPL and SEL exposures are computed for each 1 dB bin. The mean value is based on the number of animats exposed at that dB level from each track iteration and population draw. The behavioral risk function curve is applied to each 1 dB bin to compute the number of behaviorally exposed animats per bin. The number of behaviorally exposed animats per bin is summed to produce the total number of behavior exposures.

Mean 1 dB bin SEL exposures are then summed to determine the number of PTS and TTS exposures. PTS exposures represent the cumulative number of animats exposed at or above the PTS threshold. The number of TTS exposures represents the cumulative number of animats exposed at or above the TTS threshold and below the PTS threshold. Animats exposed below the TTS threshold were grouped in the SPL category.

F.7.1 Bootstrap Approach

Estimation of exposures in NAEMO is accomplished through the use of a simple random sampling with replacement by way of statistical bootstrapping. This sampling approach was chosen due to the fact that the number of individuals of a species expected within an area over which a given Navy activity occurs is often too small to offer a statistically significant sampling of the geographical area. Additionally, NAEMO depends on the fact that individual animats move vertically in the water column at a specified displacement frequency for sufficient sampling of the depth dimension. By overpopulating at the time of animat distribution and drawing samples from this overpopulation with replacement, NAEMO is able to provide sufficient sampling in the horizontal dimensions for statistical confidence. Sampling with replacement also produces statistically independent samples, which allows for the calculation of metrics such as standard error and confidence intervals for the underlying Monte Carlo process.

For each scenario and each species, the number of samples equating to the overpopulation factor is drawn from the raw data. Each sample size consists of the true population size of the species evaluated. Exposure data is then computed for each sample using 1 dB exposure bins. The average number of exposures across the sample and scenario iteration is then computed.

For example, assuming that an overpopulation factor of 10 was defined for a given species and that 15 ship track iterations were completed. The bootstrap Monte Carlo process would have generated statistics for 10 draws on each of the 15 raw animat data files generated by the 15 ship tracks evaluated for this scenario, thereby yielding 150 independent sets of exposure estimates. Samples drawn from the overpopulated population are replaced for the next draw, allowing for the re-sampling of animals. The resultant 150 sets of exposures were then combined to yield a mean number of exposures and a 95 percent confidence interval per species for the scenario. In addition to the mean, the statistics included the upper and lower bounds of all samples.

F.7.2 Estimated Exposures

Based on the methodology contained herein, Appendix Table F-3 provides the modeled marine mammal exposures associated with the thresholds defined in Section F.5.

Appendix Table F-3. Predicted Marine Mammal Exposures.

Common Name	Behavioral	TTS	PTS
Pinnipeds			
Bearded Seal	10	3	0
Ringed Seal	3,976	910	0

APPENDIX G PREPARERS

Name	Role	Education and Experience
Naval Undersea Warfare Center, Division Newport		
Code 1023, Environmental Branch, Mission Environmental Planning Program		
Jen James	Project Lead, Project Coordination, Document Development	MESM Wetlands Biology, B.S. Wildlife Biology and Management. Experience: 17 years Environmental Planning, Biological Research 20 years.
Emily Robinson	Document Development	Masters of Environmental Science and Management, B.S. Integrated Science and Technology. Experience: 5 years Environmental Planning
Code 70, Ranges, Engineering, and Analysis Department		
Kevin Nelson	Oceanographer, Marine Mammal Modeling and Prototyper	Masters of Oceanography, B.S. Biology. Modeling and Prototype Experience: 4 years
McLaughlin Research Corporation (MRC)		
Jessica Greene	GIS Analyst	B.S. Fisheries Science and Management, Experience: 5 years Marine Acoustic Modeling, 4 years GIS Analysis

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