FINAL

Supplemental Environmental Assessment/ Overseas Environmental Assessment for Ice Exercise 2024

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SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT/OVERSEAS ENVIRONMENTAL ASSESSMENT

FOR THE ICE EXERCISE PROGRAM

Lead Agency: Department of the Navy

Cooperating Agency: National Marine Fisheries Service

Title of the Proposed Action: Ice Exercise Program

Designation: FINAL

ABSTRACT

The United States (U.S.) Department of the Navy (Navy) prepared this Supplemental Environmental Assessment (EA)/Overseas Environmental Assessment (OEA) in compliance with the National Environmental Policy Act (NEPA) and Executive Order 12114, Department of Defense regulations found at 32 Code of Federal Regulations Part 187, Department of Defense Directive 6050.7, and the Chief of Naval Operations Instruction 5090.1E and its accompanying manual (M-5090.1).

This Supplemental EA/OEA evaluates the potential impact to the environment from an 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 United States Code (U.S.C.) § 8062, and to support the aims of the Arctic Research and Policy Act (15 U.S.C. §§ 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 Supplemental EA/OEA evaluates two alternatives: the No Action Alternative and the Proposed Action.

In this Supplemental EA/OEA, the Navy analyzed potential impacts to the environment that could result from the No Action Alternative or the Proposed Action. The only resources evaluated were marine mammals because all other resources were fully analyzed in the previous programmatic ICEX EA/OEA, which was written in 2021 for ICEX activities in 2022. The analysis and activities in that programmatic EA/OEA are still relevant to the planned 2024 activities.

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Executive Summary

PROPOSED ACTION

A Programmatic Ice Exercise (ICEX) Environmental Assessment (EA)/Overseas Environmental Assessment (OEA) written in 2021 for activities to be performed in 2022 (hereinafter the ICEX EA/OEA) analyzed the conduct of an ICEX, which involves submarine training and testing, as well as scientific research as time and resources allow, within the Study Area (Figure 2-1), including construction of a temporary camp on an ice floe to support the submarine training and testing. Both the 2022 ICEX and the 2024 ICEX would occur within the same Study Area, including the deep Arctic Ocean basin near the North Pole.

The activities analyzed in the ICEX EA/OEA included the establishment of a tracking range and temporary ice camp, and if resources were available, conducting research in an Arctic environment. The purpose of that proposed action was to evaluate the employment and tactics of submarine operability in Arctic conditions. In addition to the primary purpose of the proposed action, military and academic institutions collaterally benefitted from the use of the ice camp to test new systems and conduct data collection and research in and about the Arctic environment.

ICEX 2024 would be conducted in a manner similar to the activities analyzed in the ICEX EA/OEA. However, no torpedo training exercises would be conducted. This Supplemental EA/OEA includes the analysis of those changes, taking into consideration updated available science, in order to provide a more complete picture of ICEX 2024.

ALTERNATIVES

For this Supplemental EA/OEA, two alternatives were analyzed: the No Action Alternative and the Proposed Action.

ENVIRONMENTAL CONSEQUENCES

The only potential environmental stressor included in this Supplemental EA/OEA includes the potential impacts from acoustic transmissions. All other stressors remain the same as those considered in the ICEX EA/OEA, and the analysis and conclusions remain largely the same. The only conclusion that is different, is the potential impacts from on-ice vehicles and human presence to one marine mammal. An updated qualitative analysis is provided in this Supplemental EA/OEA for these stressors for one species. The potential environmental consequences of acoustic transmissions have been analyzed in this Supplemental EA/OEA for marine mammals; all other physical, biological, and socioeconomic resources were analyzed in the ICEX EA/OEA. The results of the analysis indicate that, with the implementation of standard operating procedures and mitigation measures, the Proposed Action would not significantly impact the natural and physical environment.

Under section 7 of the Endangered Species Act (ESA), the United States (U.S.) Department of the Navy (Navy) requested informal consultation with the U.S. Fish and Wildlife Service (USFWS) for the polar bear (*Ursus maritimus*). A formal consultation under section 7 of the ESA was requested for the ringed seal (*Phoca hispida)* with the National Marine Fisheries Service (NMFS) that acoustic transmissions associated with the Proposed Action are likely to adversely affect ringed seals only, but the other elements of the Proposed Action are not likely to adversely affect ringed seals. In accordance with the Marine Mammal Protection Act (MMPA), an application for an Incidental Harassment Authorization (IHA) was prepared for the harassment of marine mammals (ringed seals) incidental to active acoustic transmissions. The Navy additionally requested an intentional take permit (for the active deterrence of polar bears) under the MMPA. The Navy completed consultation with NMFS in accordance with the Magnuson-Stevens Fishery Conservation and Management Act for a previous ICEX in 2016. Since NMFS determined that the Proposed Action would not likely affect essential fish habitat and no conservation recommendations were provided, consultation was not reinitiated for future ICEX activities, including proposed 2024 activities. 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 for the previous ICEX in 2022, which is in effect until 2026.

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Acronyms and Abbreviations

cm	centimeter(s)
dB	decibel(s)
DPS	Distinct Population Segment
EA	Environmental Assessment
EO	Executive Order
ESA	Endangered Species Act
FR	Federal Register
ft	foot/feet
gal	gallon(s)
gal/day	gallon(s) per day
Hz	Hertz
ICE	under-ice model
ICEX	Ice Exercise
ICEX24	Ice Exercise occurring in year 2024
IHA	Incidental Harassment Authorization
in	inch(es)
km	kilometer(s)
km^2	square kilometer(s)
kHz	Kilohertz
L	liter(s)
L/day	liter(s)/day
m	meter(s)
mi	mile(s)
mi^2	square mile(s)
MMPA	Marine Mammal Protection Act
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
OAML	Naval Oceanographic Office's Oceanographic and Atmospheric Master Library
OEA	Overseas Environmental Assessment
PTS	Permanent Threshold Shift
re 1 μPa	referenced to 1 micropascal
re 1 $\mu Pa^2 s$	referenced to 1 micropascal squared second
SEL	Sound Exposure Level
SPL	Sound Pressure Level
TTS	Temporary Threshold Shift
U.S.	United States
U.S.C.	United States Code
USFWS	United States Fish and Wildlife Service

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 in the Arctic includes Admiral Byrd's historic overflight of the North Pole in 1926; various campaigns in World War II; consistent activity during the Cold War; and modern combined exercises with surface, subsurface, aviation, and expeditionary forces. 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. Melting polar ice and political tensions with other Arctic nations (i.e., Russia) are increasing the importance of military readiness in the Arctic.

In 2020, Arctic sea ice reached its second smallest yearly extent in recorded history, breaking the previous record set in 2007 (NOAA National Centers for Environmental Information 2022). 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" (Gilday et al. 2021).

Ice Exercises (ICEXs) are typically conducted every two years in the waters north of Alaska. ICEXs are conducted to allow for the continued training of submarine forces in the Arctic and to refine and validate procedures and required equipment (hereafter referred to as "training and testing"). Additionally, military and academic institutions collaborate with the Navy during each ICEX to further their research objectives of better understanding the Arctic environment and the suitability and survivability of particular technologies in the environment.

The Navy prepared this Supplemental Environmental Assessment (EA)/Overseas Environmental Assessment (OEA) to analyze the potential impacts from a proposed 2024 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 Part 187, and the Chief of Naval Operations Instruction 5090.1E and its accompanying manual (M-5090.1; June 25, 2021). The Supplemental EA/OEA was used in support of applications for one-year Incidental Harassment Authorization (IHA) submitted by the Navy under the Marine Mammal Protection Act (MMPA) to the National Marine Fisheries Service (NMFS) and to the U.S. Fish and Wildlife Service (USFWS). Once issued, an IHA would allow the non-intentional, "take by harassment" of marine mammal's incidental to the training and testing activities within the Study Area. The Supplemental EA/OEA additionally was used for updated consultations with NMFS and USFWS under the Endangered Species Act (ESA).

1.2 Purpose and Need

The primary purpose of the Proposed Action is to evaluate the employment and tactics of submarine operability in Arctic conditions; this overall purpose has not changed since it was fully analyzed in the EA/OEA written for the ICEX program in 2022 (U.S. Department of the Navy 2021), (referred to herein as "ICEX EA/OEA"). Secondarily, the Proposed Action would test emerging technologies and assess capabilities in the Arctic 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.) § 8062 and the strategies outlined in *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 Supplemental 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

Laws and directives applicable to Ice Exercise (ICEX) 2024 (hereinafter ICEX24) are listed below, but described in full detail in the ICEX EA/OEA. Applicable laws and directives include:

- National Environmental Policy Act (NEPA)
- Executive Order (EO) 12114
- Arctic Research and Policy Act
- Clean Water Act
- Endangered Species Act (ESA)
- Marine Mammal Protection Act (MMPA)
- Magnuson-Stevens Fishery Conservation and Management Act (MSA)
- Migratory Bird Treaty Act (MBTA)

2 Proposed Action and Alternatives

The activities analyzed in this Supplemental EA/OEA are largely a continuation of activities that were analyzed previously in the ICEX EA/OEA. This Supplemental EA/OEA includes any changes to activities previously analyzed, and it reflects the most up-to-date compilation of training and testing activities deemed necessary to accomplish military readiness requirements.

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 camp, and if resources are available, the Proposed Action also would include conducting research in an Arctic environment. The objective of the Proposed Action is to evaluate the employment and tactics of submarine operability in Arctic conditions. The Navy's Proposed Action also would evaluate emerging technologies and assess capabilities in the Arctic environment and gather data on Arctic environmental conditions. NMFS' proposed action is to issue one-year IHAs 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 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 ICEX 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 Study Area" in Figure 2-1).

Though the configuration of equipment and/or the types of equipment used may differ between the ICEX EA/OEA and this Supplemental EA/OEA, the general activities would remain the same. Broadly, the Proposed Action for this Supplemental EA/OEA differs from the ICEX EA/OEA action only in that there would be no use of exercise torpedoes.

The Proposed Action, including the construction and demobilization of the ice camp, would occur over approximately a six-week period from February through April (considered winter through early spring). The submarine training and testing and the research activities would occur over approximately four weeks during the six-week period. 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. The camp should be fully functional within five days after initial flights to drop-off equipment.

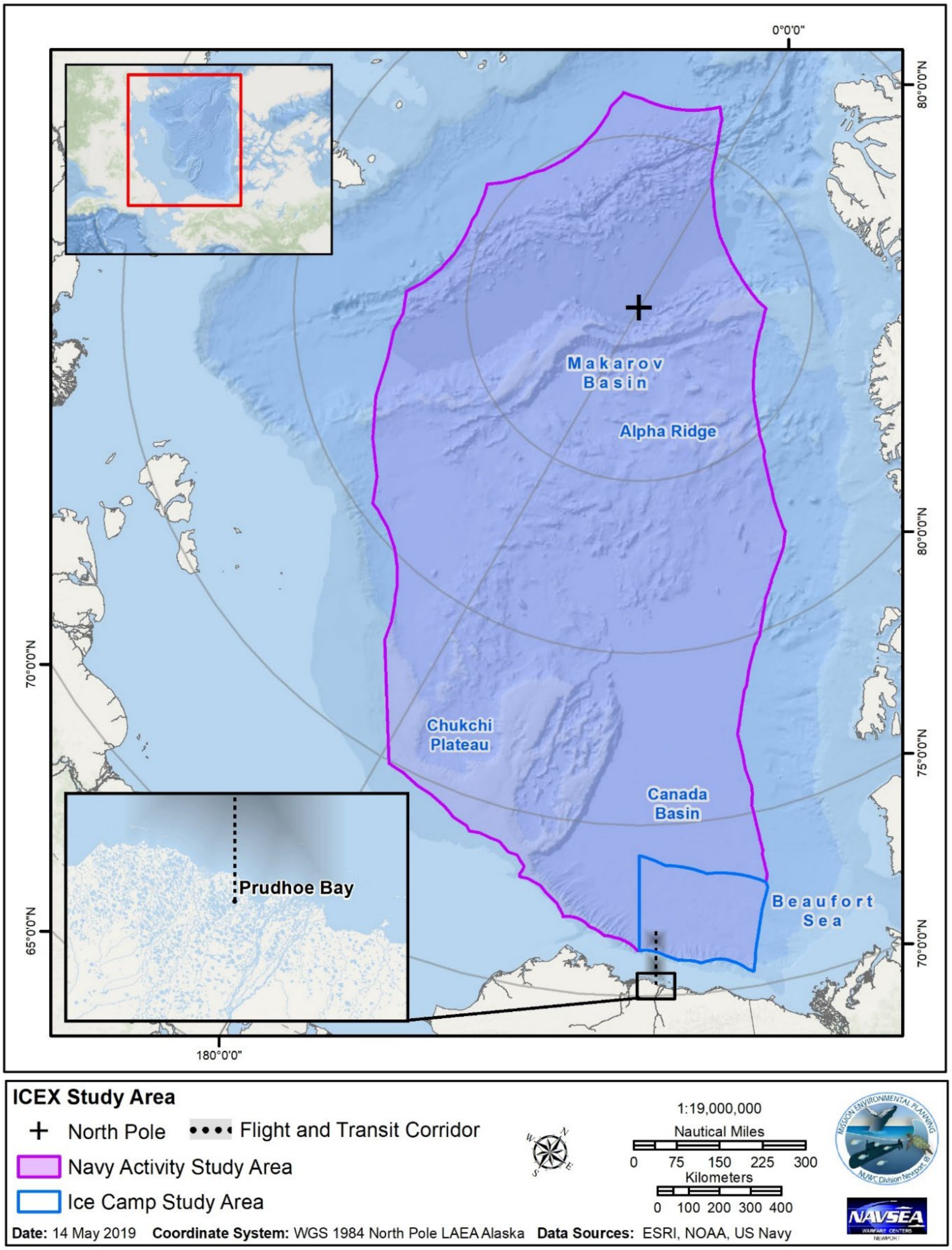

Figure 2-1. ICEX Study Area

2.1.1 Ice Camp

For the purposes of this Supplemental EA/OEA, the ice camp would operate in the same manner as was described in the ICEX EA/OEA. 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 2-2). The number of structures/tents would range from 15 to 20, and structures typically would be 7 to 20 feet (ft; 2 to 6 meters [m]) by 20 to 33 ft (6 to 10 m) in size. Some tents may be octagon shaped and approximately 20 ft (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 mile (mi; 1.6 kilometers [km]) in diameter. Support equipment for the ice camp includes snowmobiles, snow blowers, gas powered augers and saws (for boring holes through the ice), two reverse osmosis units, and diesel generators.

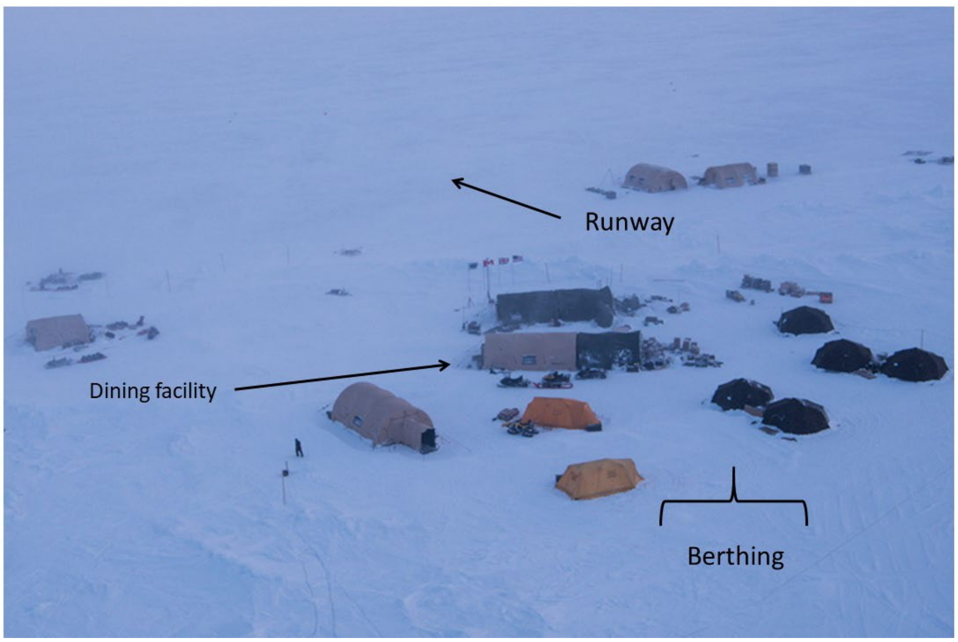

Figure 2-2. Example Ice Camp

All ice camp materials, fuel, and food would be transported from Prudhoe Bay, Alaska, and delivered by either 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 and commercial helicopters). Aircraft would be used to transport personnel and equipment from the ice camp to Prudhoe Bay; up to nine round trips would occur daily during ice camp build-up and demobilization. At the completion of ICEX, 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 ICEX24; hydrophones would be deployed on the ice and extending to approximately 98 ft (30 m) below the ice. Hydrophones would be approximately 4.65 inches (in; 11.8 centimeters [cm]) in length and have 2,000 ft (610 m) in associated cables. The associated cable would be Kevlar reinforced with a long-life polyurethane jacket for durability. The hydrophones would be deployed by drilling/melting 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. Additionally, hydrophones for research purposes could be deployed up to 1,641 ft (500 m), and would be recovered if possible.

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 that 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 gray 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 0.06 in (0.16 cm). Solids captured in the screen would be disposed of via the camp's solid waste containers and brought back to Prudhoe Bay, Alaska, for disposal. 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 (gal/day; 379 liters per day [L/day]), with a maximum discharge rate of 155 gal/day (587 L/day) during the two weeks of peak camp operations. The estimated total discharge from the ice camp's dining facility is 2,925 gallons (gal; 11,072 liters [L]).

Most freshwater for drinking and meal preparation would be produced by reverse osmosis through desalination. However, the camp also may 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 be discharged at the camp via a single drain (corrugated pipe placed through a hole in the ice) co-located with the portable system. The average reject water production is expected to be 144 gal/day (545 L/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 600 gal/day (2,271 L/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 four 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 gal (30,526 L).

Sanitary/human waste generated at the camp would be collected in zero-discharge sanitary facilities (e.g., barrels lined with a plastic bag), which would then be containerized and 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 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 mi (40 km) wide and is the most direct route to the camp.

An average of 6 to 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 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.

2.1.3 Submarine Training and Testing

Submarine activities associated with ICEX24 are classified, but they generally entail safety maneuvers and active sonar use similar to submarine activities conducted in other undersea environments. These maneuvers and sonar use would be conducted in the Arctic to test their performance in a cold environment. Classified descriptions of submarine training and testing activities planned for ICEX24 can be provided to authorized individuals upon request. Submarine training and testing involves active acoustic transmissions.

2.1.4 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 ICEX24 has been reviewed and placed into one of seven general categories of actions (Table 2-1); these categories of actions are analyzed herein or were analyzed in the ICEX EA/OEA and remain unchanged. 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.

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 impacts to the environment. No significantly different platforms for on-ice vehicles, aircraft, passive scientific devices, or unmanned underwater vehicles have been proposed in ICEX24 that were not analyzed in the ICEX EA/OEA; therefore, platform descriptions are not repeated herein. New active acoustic devices have been suggested, and these devices are described below (Section 2.2.1).

Table 2-1. Summary of ICEX24 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	On-Ice Data Collection	Ice Cores/Snow Samples	Collection of ice cores and/or snow to obtain abiotic (e.g., snow depth, thermal properties) and/or biotic (e.g., eDNA, microbial communities) information.
		Sensors	Use of sensors to measure ice thickness.
	In-water Device Data Collection Personnel/ Equipment Proficiency	Buoys	Deployment of buoys to collect abiotic measurements (e.g., climate data, light transmission) and biotic measurements (e.g., phytoplankton blooms).
		Sensors	Deployment of various remote sensor nodes to collect measurements on photosynthetic light levels, speed of different sounds, conductivity, temperature, and depth.
		Unmanned Underwater Vehicle	Deployment of autonomous and tethered unmanned underwater vehicle to measure sea-ice ocean interactions, such as exchanges of heat, salt, and momentum with sea-ice.
		Water Samples	Collection of water samples under the ice for eDNA analysis.
		Training and Support	Personnel conduct various activities in extreme cold, including, but not limited to, combat casualty care protocols, expeditionary ice diving operations, expeditionary camp construction operations support/maintenance, infiltration, special operations, and exfiltration.
	Underwater Equipment Testing	Acoustics/ Communication	Various communication systems and/or acoustic sources deployed under the ice, or in the water column, to determine system signal recognition capabilities.
		Unmanned Underwater Vehicle	Autonomous unmanned underwater vehicle deployed to test communication and range of vehicle along with the vehicles ability to sample under-ice and in the open Arctic Ocean.
	Aerial System Testing	Unmanned Fixed-Wing	Fixed-wing unmanned aerial systems launched by hand or by pneumatic catapult. Fixed-wing systems may have up to 15-ft (4.6-m) wingspan and up to a 6.5 hour endurance.
	Unmanned On-Ice System Testing	Unmanned On-Ice Vehicle	Autonomous unmanned vehicle (e.g., electric snowmobile)deployed to test real-time ice detection, navigation, and provide various real-time monitoring data (e.g., meteorological data, ice thickness).

eDNA = environmental deoxyribonucleic acid; ft = feet; m = meters

2.2.1 Scientific Active Acoustic Devices

One unmanned underwater vehicle would be deployed under the ice to test the communication and range of the vehicle and to conduct under-ice and in-water column sampling. Several other acoustic sources (i.e., echosounder, transducers) would be deployed under the ice, or in the water column, to determine systems signal recognition capabilities. Acoustic parameters for these active sources are in Table 2-2. The parameters for some active acoustic sources associated with research activities are classified.

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

Research Institution	*Source Name*	*Frequency Range (kHz)*	*Source Level (dB)*	*Pulse Length*	*Source Type*
Woods Hole Oceanic Institute	LRAUV+	10 and 25	185 or less	14 and 3000 ms	Unmanned Underwater Vehicle
Naval Postgraduate School	Echosounder[1]	38 to 200	221	0.5 ms	Sonar
Massachusetts Institute of Technology Lincoln Lab	Echosounder[1]	115 and 200	227 or less	1 ms	Sonar
Naval Postgraduate School	Geospectrum M72, Geospectrum M71, ITC 1007	0.13, 0.8, and 5	190 or less	maximum length sequence of 20 min on and 40 min off	Transducer

dB = decibels; kHz = kilohertz; LRAUV+ = Long Range Autonomous Underwater Vehicle Plus; min = minutes; ms = millisecond(s)

[1] Echosounders are a type of sonar. Echosounders have transducers that send sound pulses (sonar signals) into the water. The signal is reflected, and the transducer receives the returning echo (DOSITS 2021).

2.3 Alternatives

Screening criteria were used in the development and selection of alternatives for the ICEX program. 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 the following:

(i) ICEX 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;

(ii) 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;

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

(iv) 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.

For the purposes of this Supplemental EA/OEA, only two alternatives will be addressed herein: a No Action Alternative and the Proposed Action.

2.3.1 No Action Alternative

Under the No Action Alternative, ICEX24 would occur as it was analyzed in the ICEX EA/OEA. This alternative requires no subsequent analysis of potential consequences to environmental resources, as all potential consequences were analyzed in the ICEX EA/OEA.

2.3.2 Proposed Action

Under the Proposed Action, the Navy would conduct the submarine training and testing activities as described in Section 2.1. In contrast to the ICEX in 2022, the Proposed Action would not include torpedo exercises. The ice camp would be established approximately 100 to 200 nautical miles (nm) north of Prudhoe Bay, Alaska in the same study area defined in the ICEX EA/OEA; 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 (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 27,172 square miles (mi^2; 70,374 square kilometers [km^2]); the actual ice camp would be no more than 1 mi (1.6 km) in diameter, approximately 0.8 mi^2 (2 km^2) in area.

The Navy's Proposed Action would occur over an approximately six-week period from February to early April 2024, including construction and demobilization of the ice camp. The submarine training and testing would occur over approximately four weeks during the six-week period.

2.3.3 NMFS Action Alternative

Under the NMFS Action Alternative, NMFS would grant one-year IHAs to the Navy for the incidental, not intentional, harassment of marine mammal 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 one-year IHAs 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 May 24, 2023 for an IHA for the harassment of marine mammals (ringed seals) incidental to training and testing activities (i.e., active acoustic transmissions) occurring over a six-week period in 2024.

2.3.4 Alternatives Eliminated from Further Consideration

Other action alternatives that were considered but did not meet the screening criteria (Section 2.3), and therefore, were not carried forward, are discussed in the ICEX EA/OEA.

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. In this Supplemental EA/OEA, only mammals are discussed (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, or it may be because the resource was analyzed in the ICEX EA/OEA and anticipated impacts remain unchanged.

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

Resource	***Potential Stressors***
Biological Environment	
Marine Mammals	Acoustic transmissions, aircraft noise, on-ice vehicle noise, on-ice vehicle strike, in-water vessel and vehicle strike, human presence, entanglement, and ingestion have the potential to impact marine mammals. All stressors other than acoustic transmissions (ringed seal) and effects of on-ice vehicles and human presence (polar bears) were analyzed in the ICEX EA/OEA, and the potential for impacts remains unchanged from that analysis.

Table 2-4. Resources Not Included In Analysis

Resource	***Reason for Elimination***
Physical Environment	
Air Quality and Greenhouse Gases	Analyzed in the ICEX EA/OEA. No new analysis required.
Airspace	The majority of the Proposed Action would occur in the water 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, the Proposed Action 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 they 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 offshore of Prudhoe Bay, Alaska on ice-covered water, not on land. Therefore, the Proposed Action would not impact land use.
Sea Ice	Analyzed in the ICEX EA/OEA. No new analysis required.
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 terrestrial biological resources would be present within the Deadhorse Airport, in Prudhoe Bay. Therefore, the Proposed Action would not impact the terrestrial environment, including parks, forests, and prime and unique farmland.
Water Quality	Analyzed in the ICEX EA/OEA. No new analysis required.
Wild and Scenic Rivers	The Proposed Action would occur on or in ocean waters. Therefore, the Proposed Action would not impact wild and scenic rivers.
Biological Environment	
Essential Fish Habitat	Analyzed in the ICEX EA/OEA. No new analysis required.
Fish	Analyzed in the ICEX EA/OEA. No new analysis required.
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.
Invertebrates	Analyzed in the ICEX EA/OEA. No new analysis required.
Marine Birds	Analyzed in the ICEX EA/OEA. No new analysis required.

Resource	***Reason for Elimination***
Marine Vegetation	Marine vegetation is present within the Study Area; however, because of the limited amount of human presence and minimal chance for interaction with marine vegetation due to the ice camp being above the ice, there would be no impact to marine vegetation.
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.
Sea Turtles	No sea turtles would be present in the Study Area. Therefore, no impact would occur to these species.
Terrestrial Wildlife	With the exception of the Arctic fox (*Vulpes lagopus*), no other terrestrial wildlife is anticipated to occur at the ice camp. Therefore, no impact would occur to these species. Impacts to Arctic fox were analyzed in the ICEX EA/OEA, and no new analysis is required.
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 to 150 nautical miles 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 in or near the Study Area. Therefore, the Proposed Action would not impact commercial and recreational fisheries.
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 or 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.
Subsistence Hunting	Analyzed in the ICEX EA/OEA. No new analysis required.
Utilities	The Proposed Action would not occur near any utilities. Therefore, the Proposed Action would not impact utilities.

3 Existing Environment

This chapter presents a description of the environmental resources that may be affected by the Proposed Action that require new analysis from the ICEX EA/OEA. As laid out in Table 2-4, the majority of resources considered in the ICEX EA/OEA do not require additional analysis herein, due to the minimal changes in the Proposed Action. Therefore, the only resources considered in this Supplemental EA/OEA are marine mammals.

3.1 Biological Resources

Biological resources include living, native, or naturalized plant and animal species and the habitats within which they occur. Plant associations are referred to, generally, as vegetation, and animal species are referred to, generally, as wildlife. Habitat can be defined as the resources and conditions present in an area that support a plant or animal.

Based upon the analysis in the ICEX EA/OEA, only marine mammals are anticipated to potentially be impacted by the Proposed Action in a manner differing from the prior analysis; therefore, only marine mammals are included herein. The acoustic parameter changes have changed the potential marine mammal exposures.

3.1.1 Mammals

Marine mammals may be present throughout the Study Area during the Proposed Action, 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 3-1 lists the mammals and stock designation, if applicable, that may occur within the Study Area during the Proposed Action. Other species, such as bowhead whales (*Balaena mysticetus*), beluga whales (*Delphinapterus leucas*), 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 they are not expected in the area during the Proposed Action. Bearded seals (*Erignathus barbatus nauticus*) were previously included in the ICEX EA/OEA, but upon additional analysis do not require further consideration.

Table 3-1. Marine 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*
Ringed seal[1]	*Phoca hispida hispida*[2]	Arctic[3]	Not within the Study Area
Polar bear[1]	*Ursus maritimus*	Southern Beaufort Sea, Chukchi/Bering Sea	Not within the Study Area

[1] Species currently listed as threatened under the Endangered Species Act.
[2] Scientific name of subspecies within the Study Area
[3] Stock is designated by the Marine Mammal Protection Act.

The only marine mammals expected to be susceptible to impacts from acoustic stressors and/or physical stressors (Table 2-2); and present in the Study Area during the Proposed Action are ringed seals (*Phoca hispida*) and polar bears (*Ursus maritimus*). Based on consultation with NMFS and the current literature (Refer to: Bengtson et al. 2005; Boveng and Cameron 2013; Cameron and Boveng 2009; Cleator et al. 1989; Crance et al. 2022; Gryba et al. 2021; Hamilton et al. 2022; Kovacs 2017; Olnes et al. 2020; Simpkins et al. 2003), it was determined that bearded seal (*Erignathus barbatus*) are unlikely to be present in the Study Area during the Proposed Action, as they are more likely to be found in the Chukchi Sea and Bering Sea during this time period. MacIntyre et al. (2013) recorded bearded seal calls throughout the year in the Beaufort Sea, with the majority of calls detected from January to July (MacIntyre et al. 2013). However, this study used passive acoustic monitoring in shallow waters of the western Beaufort Sea. Cleator et al. (1989) indicated that bearded seal trills can be heard for up to 15.5 mi (25 km) underwater. If we assume that bearded seals were observed 15.5 mi (25 km) from the passive acoustic monitoring equipment, then seals would be well inshore from the ice camp location.

Details about the geographic range, habitat, distribution, and hearing of ringed seals and polar bears are discussed below.

3.1.1.1 Ringed Seal

The ringed seal, specifically the Arctic subspecies (*Phoca hispida hispida*), occurs within the U.S. Exclusive Economic Zone of the Beaufort, Chukchi, and Bering Seas and would be expected to occur within the Study Area (Hamilton et al. 2022; Kelly et al. 2009; Muto et al. 2021; Palo 2003; Palo et al. 2001). There is not a reliable population estimate for the subspecies (Muto et al. 2021). The Arctic subspecies is listed as depleted and strategic under the MMPA (Muto et al. 2021). The ringed seal is listed as threatened under the ESA (77 FR 76706; December 28, 2012). In 2022, NMFS designated critical habitat for the Arctic subspecies of ringed seal (87 FR 19232; April 1, 2022). The ringed seal critical habitat includes regions of the northern Bering, Chukchi, and Beaufort Seas, but it does not overlap with the Ice Camp Study Area (Figure 3-1). Only the transit between Deadhorse Airport and the ice camp would overlap with critical habitat. The physical and biological features that are necessary to conserve the Arctic subspecies, (i.e., snow-covered sea ice habitat that allows for creation of subnivean lairs used for sheltering of pups in the whelping and nursing period, sea ice habitat that allows for molting and basking, and primary prey organisms needed to maintain ringed seals energy budgets), are not relevant to the flight corridor because none of the biological and physical features are found at the elevation transit occurs.

Ringed seals have a wide distribution in seasonally and permanently ice-covered waters of the Northern Hemisphere (North Atlantic Marine Mammal Commission 2004), and they are the most common pinniped in the Study Area. Ringed seals have an affinity for ice-covered waters and are well adapted to occupying both shore-fast and pack ice (Gryba et al. 2021; Kelly 1988b). Ringed seals can be found farther offshore than other pinnipeds, since they can maintain breathing holes in ice thickness greater than 7 ft (2 m) (Smith and Stirling 1975). Breathing holes are maintained by ringed seals' claws on their fore flippers (Kelly 2022). 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 all times of the year (Kelly 2022). 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; Von Duyke et al. 2020). Passive acoustic monitoring of ringed seals from a high frequency recording package deployed at a depth of 787 ft (240 m) in the Chukchi Sea 75 mi (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). Telemetry data from Von Duyke et al. (2020) indicated that ringed seals occupy the Chukchi Sea and Bering Strait during the winter months.

Ringed seals have at least two distinct types of subnivean lairs: haul out lairs and birthing lairs (Smith and Stirling 1975). Haul out lairs are typically single-chambered (Hauser et al. 2021) 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 assumed to be found within the sea ice in the Ice Camp Study 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 five to nine weeks during late winter and spring (Chapskii 1940; McLaren 1958; Smith and Stirling 1975). Snow depths of at least 20 to 26 in (50 to 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 8 to 12 in (20 to 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). Pupping begins in March, but the majority of births occur in early April. About a month after parturition, mating resumes in late April and early May.

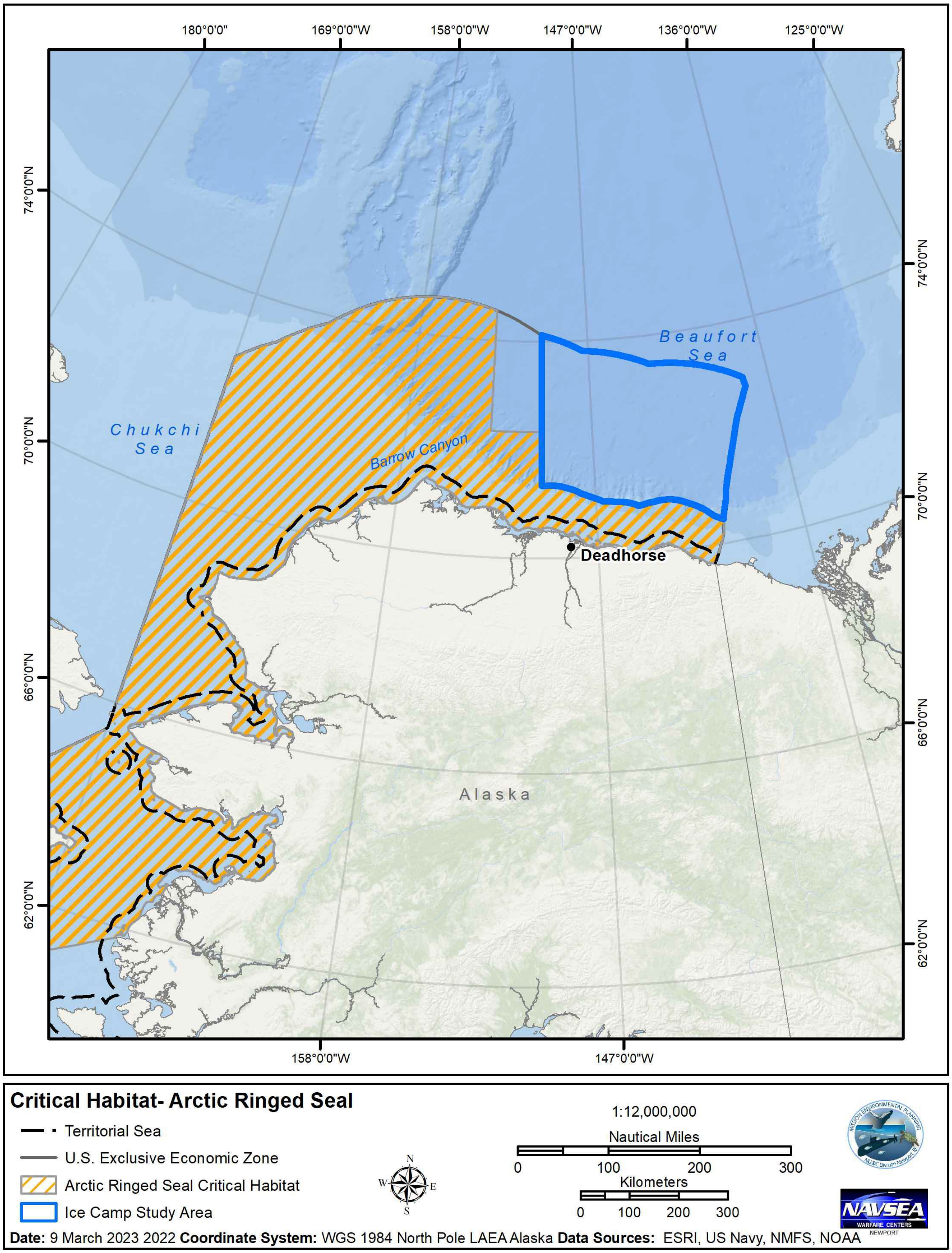

Figure 3-1. Designated Critical Habitat for Ringed Seals

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 Arctic cod (Ghazal 2021; Quakenbush et al. 2020). Ringed seals also prey upon saffron cod, which is particularly important during the summer months in Alaskan waters (Crawford et al. 2015; 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., *Gammarus* spp.), krill (e.g., *Thysanoessa* spp.), mysids (e.g., *Neomysis rayii*), shrimps (e.g., *Pandalus* spp., *Eualus* spp.), and cephalopods (e.g., *Gonatus* spp.) are consumed by ringed seals (Crawford et al. 2015; Ghazal 2021).

3.1.1.2 Pinniped Hearing

Ringed seals fall into the phocid seal hearing group. Functional hearing limits for this hearing group are estimated to be 75 hertz (Hz) to 30 kilohertz (kHz) in air and 75 Hz to 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). Phocids can make calls between 90 Hz and 16 kHz (Richardson et al. 1995). The generalized hearing for phocids (underwater) ranges from 50 Hz to 86 kHz (NMFS Office of Protected Resources 2018), which includes the suggested auditory bandwidth for pinnipeds in water proposed by Southall et al. (2007), ranging between 75 Hz and 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 (dB) referenced to 1 micropascal (re 1 µPa) at 1 m, respectively. The best hearing range for ringed seals combined was 400 Hz 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.

3.1.1.3 Polar Bear

Two polar bear stocks occur within the Study Area: (1) the SBS stock and (2) the Chukchi/Bering Seas (CBS) stock. The SBS and CBS stocks are listed as depleted and classified as strategic under the MMPA. Both stocks are listed as threatened under the ESA (73 FR 28212; May 15, 2009). Polar bears from the SBS and CBS stocks may be present within the Study Area. There are no reliable population estimates for either stock. In 2010, USFWS designated 187,157 mi^2 (484,734 km^2) of on-shore and off-shore critical habitat for polar bears (75 FR 76086 76137). Polar bear critical habitat extends out from the shoreline into the Study Area. The designated critical habitat does not overlap with the Ice Camp Study Area (Figure 3-2). Only the transit between Deadhorse Airport and the ice camp would overlap with critical habitat. The physical and biological features that are necessary to conserve the Arctic subspecies, (i.e., sea ice habitat that allows for hunting and feeding, sea ice and terrestrial habitats that allow for traveling, sea ice and terrestrial habitats that allow for resting, terrestrial habitat that allows for reproduction, sea ice and terrestrial habitats that allow for denning, and primary prey organisms needed to maintain polar bears energy budgets), are not relevant to the flight corridor because none of the biological and physical features are found at the elevation transit occurs.

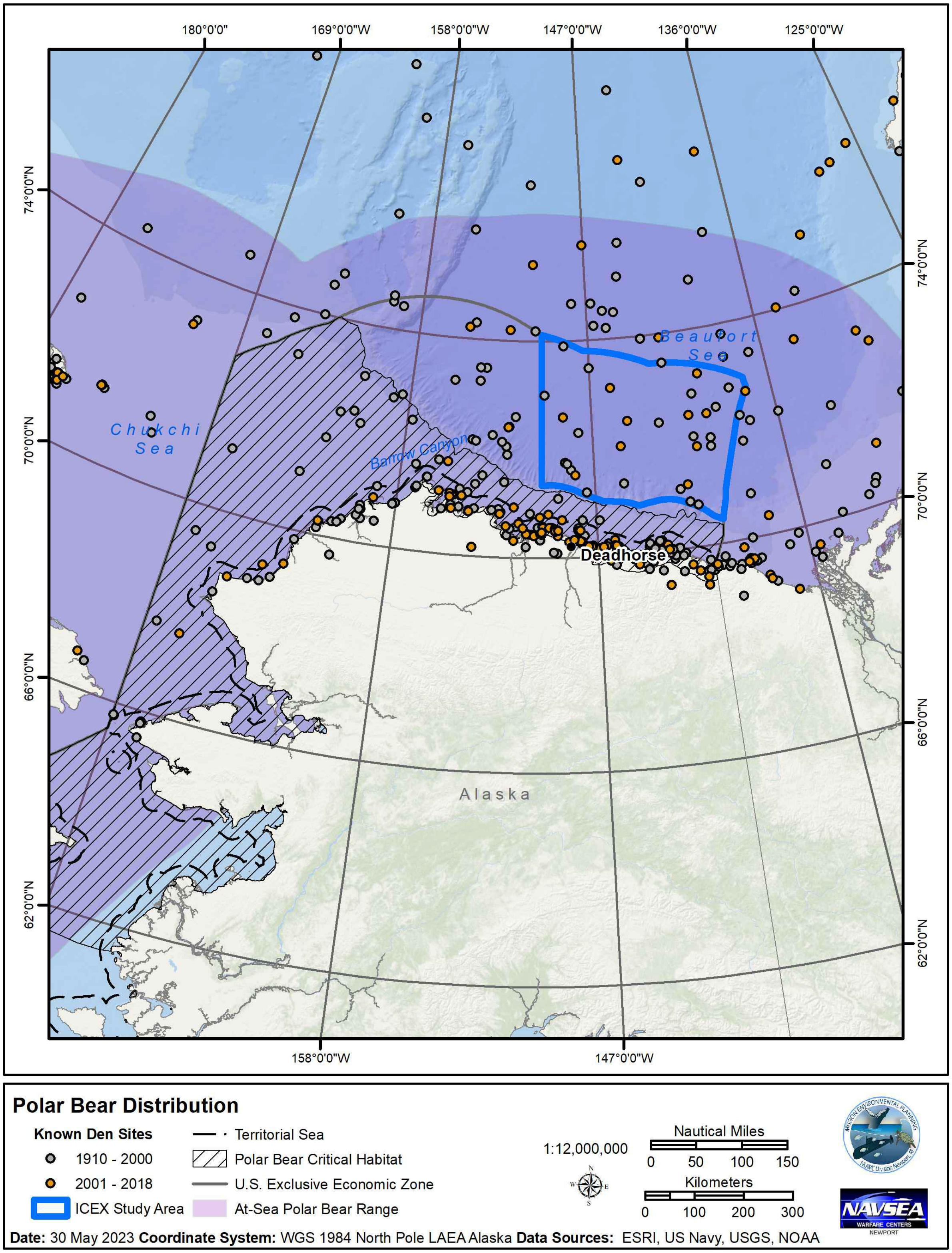

Figure 3-2. At-Sea Distribution and Designated Critical Habitat for Polar Bears

The CBS stock is widely distributed on the pack ice in the Chukchi Sea, northern Bering Sea, and adjacent coastal areas in Alaska and Russia. The CBS stock western boundary is north of the Kolyma River, Russia, and the eastern boundary is potentially as far as Camden Bay, Alaska (Garner et al. 1990; U.S. Fish and Wildlife Service 2021a). An extensive area of overlap between the SBS stock and the CBS stock occurs between Point Barrow and Point Hope, centered near Point Lay (Amstrup 2000; Garner et al. 1994; Garner et al. 1990; U.S. Fish and Wildlife Service 2021a). It is uncertain where the boundary occurs between the CBS and SBS stocks in the western Beaufort Sea and eastern Chukchi Sea (U.S. Fish and Wildlife Service 2021a).

The SBS 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 SBS concentrate in waters less than 984 ft (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; Stern and Laidre 2016; Stirling et al. 1999). The exact location of the eastern boundary of the SBS stock is uncertain (U.S. Fish and Wildlife Service 2021b). It has been suggested that the eastern boundary occurs south of Banks Island and east of the Baillie Islands, Canada (Amstrup et al. 2000), but capture-recapture and harvest data suggest that the eastern boundary is located farther west near Tuktoyaktuk, Canada (Regehr et al. 2006; Stirling et al. 2011). The western boundary of the SBS stock is near Icy Cape, Alaska (U.S. Fish and Wildlife Service 2021b). The southern boundary of the SBS 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.

Mating occurs in late March through early May (Lønø 1970; Stirling et al. 2016), which overlaps with the timeframe of the Proposed Action. During the breeding season, males find estrous females by sniffing their footprint tracks (Owen et al. 2015). In November and December, pregnant females dig dens in pressure ridges in fast ice, drifting pack ice, or on land (up to 100 mi [161 km] inland). Females give birth to their cubs from December to January and stay within their dens until spring (Reeves et al. 2002). It is rare that CBS bears and SBS bears den within the same region (Durner 2020; Rode et al. 2015).

Each year, only 25 percent of reproductively active females produce a litter. The U.S. Geological Survey has cataloged polar bear den locations for three regions (Beaufort Sea, Chukchi Sea, and northwestern Canada) between 1910 and 2018 based on previous studies (Durner 2020). Dens were found on land and in the sea for all three regions. Conclusions were not able to be drawn as to the frequency of dens on land versus sea due to biases in sampling efforts (Durner 2020). There were 11 dens identified in within the Ice Camp Study Area during 2001 to 2018. 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 3-2 based off of the U.S. Geological Survey study (Durner 2020).

Non-denning females and male polar bears remain active throughout the whole year and roam the pack ice in the winter months to hunt for prey (Fischbach et al. 2007; NWF 2023). The size of a polar bear's range depends on a number of factors, including habitat quality, the amount of space a bear needs to reproduce, and the amount of available food (Auger-Methe et al. 2016; Pagano et al. 2021; Polar Bears International 2015). Polar bears have large home ranges, partially because they feed on seals on drifting pack ice. Sea ice travels approximately 3.20 mi per day (5.14 km per day) in the Chukchi Sea and 2.80 mi per day (4.51 km per day) in the Beaufort Sea (Durner et al. 2017). Polar bears need to follow the pack ice as it moves in order to hunt their prey.

Polar bear primary prey is seals, particularly ringed seals. Occasionally, polar bears are known to prey upon walruses (*Odobenus rosmarus divergens*) or beluga whales (*Delphinapterus leucas*) trapped by ice, and they may also consume carrion when prey is scarce (U.S. Fish and Wildlife Service 2014).

3.1.1.4 Polar Bear Hearing

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 hertz (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 to 35 kHz in air and 50 Hz to 50 kHz in water (Southall et al. 2007). Polar bear cubs have a nursing vocalization that ranges from 280 to 850 Hz (Derocher et al. 2010).

4 Environmental Consequences

This chapter discusses the potential environmental consequences of the Proposed Action to the natural and physical resources described in Chapter 3, for which the analysis or stressors differ from the ICEX EA/OEA. The only stressor resulting from the Proposed Action that may potentially impact or harm the biological or physical environment that differs from the analysis in the ICEX EA/OEA is active acoustic transmissions. Therefore, only active acoustic transmissions will be analyzed for the impacts to those biological resources affected. The remaining environmental consequences were analyzed in the ICEX EA/OEA:

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

Under the No Action Alternative, ICEX24 would occur as described in the ICEX EA/OEA; therefore, no additional analysis is included herein.

Under the Proposed Action, all stressors except for acoustic transmissions would be the same as were analyzed in the ICEX EA/OEA, so they will not be re-analyzed herein. While the exact acoustic transmissions associated with the Proposed Action would vary overall based upon different testing and research projects, the key difference from ICEX would be the removal of the exercise torpedoes from the Proposed Action.

The impacts of acoustic transmissions on most resources is limited to qualitative analysis as there is insufficient data available for a quantitative analysis. The acoustic transmission changes associated with the Proposed Action for ICEX24 would not create notable differences in the qualitative analysis, and therefore, these analyses would not change from the ICEX EA/OEA and will not be included herein. However, quantitative analysis is feasible for marine mammals, and an updated analysis is necessary both under NEPA and for obtaining permits under the ESA and MMPA. Therefore, an updated analysis of the impacts of acoustic transmissions on marine mammals is provided herein.

A quantitative assessment is presented below for polar bears, as the Navy has determined that the use of on-ice vehicles and human presence have the potential to impact polar bears that may be present within the Study Area.

4.1 Acoustic Stressors to Phocids

The only acoustic stressor analyzed from the Proposed Action is active acoustic transmissions.

Both submarine training and research activities have acoustic transmissions that require quantitative analysis. 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 impacts to marine species. Potential impacts from these "*de minimis*" sources are analyzed qualitatively in accordance with current Navy policy. Navy acoustic sources are categorized based on frequency, source level, and mode of usage. The acoustic transmissions associated with submarine training can be high-frequency hull-mounted submarine sonars greater than 10 kHz but less than 200 kHz signals, hull-mounted submarine sonars that produce mid-frequency (1 to 10 kHz) signals, and mid-frequency acoustic modems greater than 190 dB re 1 µPa. This differs from the ICEX EA/OEA in that there would be no acoustic transmissions associated with exercise torpedoes, because torpedoes would not be used in the Proposed Action. The parameters for the acoustic transmissions associated with unclassified research activities can be found in Table 2-2. All 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 A for authorized individuals. 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 also can 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, TTS is characterized by the 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 they may exhibit alertness or avoidance behavior (Richardson et al. 1995).

Masking: The presence of intense sounds or sounds within a mammal's hearing range in the environment potentially can interfere with the 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 being preyed upon or being unable to find food (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 only marine mammals susceptible to impacts from acoustic transmissions from the Proposed Action would be ringed seals, because polar bears would be expected to remain on the ice surface and not be exposed to acoustic transmissions in the water column. In assessing the potential impacts on ringed 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 previously used to produce a quantitative estimate of PTS, TTS, and behavioral exposures for ringed seals (see Appendix F in ICEX EA/OEA for additional details on NAEMO and the modeling process). For ICEX24, a new approach was used and is described below. The Navy then further analyzed the data and conducted an in-depth qualitative analysis of the species' distributions and likely responses to the acoustic transmissions based on available scientific literature. The determination of the impacts to the ringed seal was based on this combination of quantitative and qualitative analyses.

4.1.1 Quantitative Analysis

The quantitative analysis herein is for the exposures associated with the proposed acoustic transmissions from both submarine training and research activities. The only marine mammal susceptible to impacts from acoustic transmissions associated with the Proposed Action would be ringed seals. Polar bears would be expected to remain on the ice surface and therefore not exposed to acoustic transmissions in the water column. Bearded seals are not expected to be within the vicinity of the Proposed Action.

No numerical data exist regarding presence of ringed seals in the ICEX Study Area during February, March, and April. Previously, density derived from a habitat suitability model (Kaschner et al. 2006) was used as an input to estimate acoustic exposures of marine mammals using NAEMO; however, this density data drastically overestimated the abundance of ringed seals in the Study Area and led to an overinflated number of modeled ringed seal takes. Instead, the number of ringed seals that are expected to occupy the ICEX Study Area was determined to be the best approach for estimating ringed seal exposure. Ringed seal presence in the ICEX Study Area was obtained using sighting data from the Ocean Biodiversity Information System-Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) (Halpin et al. 2009). The ICEX Study Area was overlaid on the OBIS-SEAMAP ringed seal sightings map that included sightings for years 2000 to 2007 and 2013. Sighting data were only available for the mid to late summer and fall months. Due to the paucity of winter and spring data, the average number of individual ringed seals per year was assumed to be present in the ICEX Study Area during the Proposed Action; therefore, it is assumed that three ringed seals would be present in the Study Area. It is assumed that the OBIS-SEAMAP reported sightings would correspond to a more accurate number of animals that could be present at the time of the Proposed Action than the previously used densities.

To be conservative, the Navy has assumed that all three ringed seals would be exposed to acoustic transmissions above the threshold for Level B take. Because a marine mammal is only considered to be taken once in a 24-hour period, it is assumed that all three ringed seals would be exposed each day of the Proposed Action (42 days total). Therefore, the Navy requests 126 Level B takes of ringed seals (Table 4-1). Unlike the NAEMO modeling approach used to estimate ringed seal takes in the ICEX EA/OEA, the occurrence method used in this Supplemental EA/OEA does not support the differentiation between behavioral or TTS exposures. Therefore, all takes are classified as being Level B.

Table 4-1. Estimated Acoustic Exposures for ICEX24 Activities

Common Name	*Level B Harassment*	*Level A Harassment*
Ringed seal	126	0

4.1.2 Qualitative Analysis

Limited or no research has been conducted on the potential behavioral responses of pinnipeds to the type of acoustic sources used during the Proposed Action. 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

The response of a marine mammal to a non-impulsive source would 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 also can affect the way an animal responds to a sound (Wartzok et al. 2003).

Southall et al. (2007), Southall et al. (2019), and Southall et al. (2021) synthesized data from many past behavioral studies and observations to determine the likelihood of PTS, TTS, and behavioral reactions at specific sound levels. Southall et al. (2019) identified TTS- and PTS-onset SEL (weighted) thresholds for phocids in water from non-impulsive sounds as 181 and 201 dB re 1 μPa^2s, respectively.

Southall et al. (2007) suggests 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). Southall et al. (2021) conducted a severity scale analysis on a study by Hastie et al. (2014). The authors noted the response of two captive gray seals to two different sonar signals (200 and 375 kHz systems). The behavioral reactions were ranked on a severity scale as a 6 (sustained avoidance where seals spent more time hauled out) for one sonar system (200 kHz) and ranked as a 5 (onset of avoidance such as heading away and/or increasing range from the source but remaining in the water) for the other sonar system (375 kHz). Gray seals showed a change in behavior at 165.7 (1/3-octave level; 200 kHz system) and 160.3 (1/3 octave level; 375 kHz system) dB re 1 μPa at 1 m root mean square (Hastie et al. 2014; Southall et al. 2021).

Other studies have experimentally examined pinniped behavioral responses to non-impulsive sources (Götz and Janik 2010; Kvadsheim et al. 2010). Captive seals exposed to non-impulsive sources with a received SPL mostly within the range of calculated exposures (142 to 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). Hooded seals (*Cystophora cristata*) indicate avoidance responses to signals above 160 to 170 dB re 1 μPa (Kvadsheim et al. 2010), and data on gray seals (*Halichoerus* *grypus*) and harbor seals indicate avoidance responses at received levels of 135 to 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. 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.

Behavioral studies have been conducted specifically on ringed seals. In one study aimed to investigate the under-ice movements and sensory cues associated with under-ice navigation of ice seals, acoustic transmitters (60 to 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 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 maintained normal behaviors (e.g., finding breathing holes).

Although a minor change to behavior may occur as a result of exposure to the acoustic transmissions associated with the Proposed Action, the Proposed Action takes place for a limited duration, causing no more than a short-term reaction by seals, after which time normal behavior would resume. Additionally, these behavioral changes largely 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) (Kelly et al. 1988).

Effects on Ringed Seals within Subnivean Lairs

Adult ringed seals spend up to 20 percent of their 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 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 (*Canis lupus familiaris*), 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. However, the camp would be built prior to the start of the season, and the exercise 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 328 ft (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 associated with the Proposed Action are unlike the low-frequency sounds and vibrations felt from approaching predators. 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 or subnivean lair relatively easily without impacting their normal behavior patterns.

4.1.3 Summary

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

Submarine training and research activities would occur over an approximate four-week period during ICEX24. During this time, the submarines, unmanned underwater vehicles, sound projectors, and transducers would conduct intermittent acoustic events, and even during these events, acoustic transmissions would not be 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 or individual seal being exposed to the submarine activity for the entirety of the four-week period is low. 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, after which time normal behavior would resume (Harris et al. 2001; Kvadsheim et al. 2010).

An individual 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 farther from the source), and an individual seal may alter its call amplitude to compensate for the transmissions. Data show that likely reactions would be within the normal repertoire of the animal’s typical movements, as seals routinely utilize a complex of breathing holes and/or lairs (Kelly et al. 1986; Smith and Hammill 1981; Smith and Stirling 1975). They also are often exposed to anthropogenic noise due to the ever increasing industrialization of the Arctic (Fournet et al. 2021). As most ringed seal lairs are only used by single seals or by a mother-pup pair, acoustic transmissions would not result in 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 associated with the Proposed Action would be expected to result in, at most, minor to moderate behavioral responses of animals, over short and intermittent periods of time, and behavioral reactions likely would not affect annual rates of recruitment or survival. 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.

Pursuant to NEPA, acoustic transmissions associated with the Proposed Action would not be likely to significantly impact ringed seals. Pursuant to EO 12114, acoustic transmissions associated with the Proposed Action would not result in significant harm to ringed seals. Since the acoustic transmissions from the Proposed Action may cause a behavioral effect (e.g., a seal temporarily avoiding an area or using a different subnivean lair farther away from acoustic transmissions) the Navy applied for an IHA from NMFS for Level B take of ringed seals in accordance with the MMPA on May 24, 2023. In accordance with the ESA, it was determined that the acoustic transmissions associated with the Proposed Action may affect, and are likely to adversely affect, ringed seals; the Navy submitted a Biological Evaluation to NMFS on August 8, 2023.

4.2 Acoustic and Physical Stressors to Polar Bears

The quantitative analysis herein is for the incidental take associated with on-ice vehicles and human presence from the Proposed Action. Refer to the ICEX EA/OEA for a complete qualitative analysis of on-ice vehicle noise and human presence to bears.

For the purpose of assessing impacts from on-land sound, the Navy assumed that 11 dens were found within the Ice Camp Study Area (43,988 mi^2 [113,927 km^2]) during a one-year period, which results in a density of 0.003 dens for the total Ice Camp Study Area. This is a conservative approach, as Durner (2020) reported 11 dens in total to be known within the Ice Camp Study Area from 2001 to 2018. It is expected that fewer than 11 dens are occupied within the Ice Camp Study Area for a given year. Maternal dens are typically occupied by three polar bears (one sow and two cubs) (Wilson and Durner 2020).

The following assumptions were used to calculate potential exposures to snowmobiles and human presence:

- The Ice Camp Study Area is 43,988 mi^2 (113,927 km^2) in total. If 11 dens are assumed in that area, the density of dens is 0.00025 dens/mi^2 (0.000097 dens/km^2).
- The ice camp would be up to 1 mi (1.6 km) in diameter, and nearly all research objectives would occur within 2 mi (3.2 km) from the edge of the ice camp. Therefore, the total area of human presence was calculated using a diameter of 5 mi (8 km); the total area of human presence was calculated to be 19.625 mi^2 (50.24 km^2).
- Three polar bears would be found in each den.

To determine the number of dens that could fall within the ice camp and scientific research area, the den density was multiplied by the area of the ice camp, which came to 0.004 dens. Due to the uncertainty of den locations in the deep Beaufort Sea, the Navy has rounded this value up to 1 den that could be exposed to the Proposed Action. Assuming three polar bears would occupy a den, the total number of polar bears assumed incidentally taken by the Proposed Action would be three.

Pursuant to NEPA, on-ice vehicle noise and human presence associated with the Proposed Action would not be likely to significantly impact polar bears. Pursuant to EO 12114, acoustic transmissions associated with the Proposed Action would not result in significant harm to polar bears. In accordance with the ESA, the Proposed Action may affect, but is not likely to adversely affect, polar bears.

4.3 Summary of Analysis

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

5 Cumulative Impacts

Chapter 5 in the ICEX EA/OEA: (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. Based on the analysis in the ICEX EA/OEA and the past, present, and reasonably foreseeable future actions within the Study Area, the ICEX program was not expected to considerably contribute to any cumulative impacts from all other actions and activities in the Beaufort Sea. As the Proposed Action for ICEX24 is nearly identical to that described in the ICEX EA/OEA, and other activities within the Study Area have not dramatically changed, the analysis for this Supplemental EA/OEA remains consistent with that in the ICEX EA/OEA.

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 mid-February and be gradual, with activity increasing over the first five days. Set-up must be completed by March 15, 2024. This allows ringed seals to avoid the camp area prior to pupping, and would not overlap with the time period when female polar bears give birth to cubs; this would further reduce potential impacts.
- Passengers on all on-ice vehicles would observe for marine and terrestrial animals; any marine or terrestrial animal observed on the ice would be avoided by 328 ft (100 m). On-ice vehicles would not be used to follow any animal, with the exception of actively deterring polar bears if the situation requires.

- Snowmobiles would follow established routes, when available. On-ice vehicles would 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.
- 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 the Proposed Action.
- Appropriate personnel (including civilian personnel) involved in mitigation and training or testing activity must complete Arctic Environmental and Safety Awareness Training. Modules include: Arctic Species Awareness and Mitigations, Environmental Considerations, Hazardous Materials Management, and General Safety
- Ice camp personnel must monitor for marine mammals in the vicinity of the ice camp and record all observations of marine mammals, regardless of distance from the ice camp, as well as the additional data indicated in section 6 of the associated IHA for ICEX24.

Shutdown and Delay Measures:

- Navy personnel would begin passive acoustic monitoring 15 minutes prior to the start of activities involving active acoustic transmissions from submarines.
- Navy personnel would delay active acoustic transmissions if a marine mammal is detected during pre-activity passive acoustic monitoring and must shutdown active acoustic transmissions if marine mammals are detected during acoustic transmissions.
- Navy personnel would not restart acoustic transmissions 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 the need to support safe operations of a drifting ice camp. Aircraft would not reduce altitude if a marine mammal is observed on the ice. In general, cruising elevation would be 1,500 ft (305 m) or higher.
- Unmanned Aircraft Systems would maintain a minimum altitude of at least 50 ft (15.2 m) 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 or within 1,500 ft (457 m) of groups of marine mammals.
- Aircraft would maintain a minimum separation distance of 1 mi (1.6 km) from groups of five or more seals.
- Aircraft would not land on ice within 0.5 mi (0.8 km) of a polar bear or of hauled out pinnipeds.

General Camp Mitigations:

- 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 would be required to complete environmental compliance training, including environmental health and safety procedures.

Appendix A 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 B LIST OF PREPARERS

Name	***Role***	***Education and Experience***
Naval Undersea Warfare Center, Division Newport		
Code 1023, Environmental Branch, Mission Environmental Planning Program		
Emily Robinson	Project Lead; Project Coordination; Document Development	Masters of Environmental Science and Management; B.S. Integrated Science and Technology; Experience: 9 years Environmental Planning
Jessica Greene	GIS Analyst	B.S. Fisheries Science and Management; Experience: 10 years GIS Analysis
McLaughlin Research Corporation		
Kayla Anatone-Ruiz	Document Development	Ph.D. in Biology; Masters of Environmental Science and Management Wetlands Biology; B.S. in Environmental Science; Experience: 1 year Environmental Planning, 10 years Biological Research

Appendix C REFERENCES

Amstrup, S. C. (2000). Polar bear. In. Truett, J. C. & Johnson, S. R. (Eds.), *The Natural History of an Oil Field: Development and Biota* (pp. 133-157). New York, NY: Academic Press.

Amstrup, S. C., Durner, G. M., Stirling, I., Lunn, N. J., & Messier, F. (2000). Movements and distribution of polar bears in the Beaufort Sea. *Canadian Journal of Zoology, 78*, 948-966.

Auger-Methe, M., Lewis, M. A., & Derocher, A. E. (2016). Home ranges in moving habitats: polar bears and sea ice. *Ecography, 39*(1), 26-35.

Bengtson, J. L., Hiruki-Raring, L. M., Simpkins, M. A., & Boveng, P. L. (2005). Ringed and bearded seal densities in the eastern Chukchi Sea, 1999–2000. *Polar Biology, 28*, 833-845. doi: 10.1007/s00300-005-0009-1.

Bethke, R., Taylor, M. K., Amstrup, S. C., & Messier, F. (1996). Population delineation of polar bears using satellite collar data. *Ecological Applications, 6*(1), 311-317. doi: 10.2307/2269574.

Boveng, P., & Cameron, M. F. (2013). *Pinniped movements and foraging: seasonal movements, habitat selection, foraging and haul-out behavior of adult bearded seals in the Chukchi Sea*. Anchorage, AK: Bureau of Ocean Energy Management, Alaska Outer Continental Shelf Region,. p. 91.

Bowles, A. E., Owen, M. A., Denes, S. L., Graves, S. K., & Keating, J. L. (2008). Preliminary results of a behavioral audiometric study of the polar bear. *The Journal of the Acoustical Society of America, 123*(5), 3509-3509.

Burns, J. J., Shapiro, L. H., & Fay, F. H. (1981). *Ice as marine mammal habitat in the Bering Sea* (Vol. 2): U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of Marine Pollution Assessment.

Cameron, M. F., & Boveng, P. L. (2009). *Habitat use and seasonal movements of adult and sub-adult bearded seals. Alaska Fisheries Science Center Quarterly Report* pp. 1-4.

Chapskii, K. K. (1940). *The ringed seal of western seas of the Soviet Arctic (The morphological characteristic, biology and hunting production)*. Leningrad, Moscow: Izd. Glavsevmorputi. p. 147.

Cleator, H. J., Stirling, I., & Smith, T. (1989). Underwater vocalizations of the bearded seal (*Erignathus barbatus*). *Canadian Journal of Zoology, 67*(8), 1900-1910.

Crance, J. L., Berchok, C. L., Kimber, B. M., Harlacher, J. M., Braen, E. K., & Ferguson, M. C. (2022). Year-round distribution of bearded seals, *Erignathus barbatus*, throughout the Alaskan Chukchi and northern Bering Sea. *Deep Sea Research Part II: Topical Studies in Oceanography, 206*, 105215.

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

Derocher, A. E., Van Parijs, S. M., & Wiig, Ø. (2010). Nursing vocalization of a polar bear cub. *Ursus, 21*(2), 189-191.

DOSITS. (2021, 2021). Discovery of Sound in the Sea Retrieved Retrieved 2021from https://dosits.org as accessed on March 8.

Durner, G. M. (2020). *Catalogue of polar bear (Ursus maritimus) maternal den locations in the Beaufort and Chukchi Seas and nearby areas, 1910–2018*. (Data Series 1121).

Durner, G. M., Amstrup, S. C., Nielson, R. M., & McDonald, T. L. (2004). *The Use of Sea Ice Habitat by Female Polar Bears in the Beaufort Sea*. (OCS study, MMS 2004-014). Alaska Science Center, Anchorage, Alaska.

Durner, G. M., Douglas, D. C., Albeke, S. E., Whiteman, J. P., Amstrup, S. C., Richardson, E., . . . Ben-David, M. (2017). Increased Arctic sea ice drift alters adult female polar bear movements and energetics. *Global change biology, 23*(9), 3460-3473.

Durner, G. M., Douglas, D. C., Nielson, R., & Amstrup, S. C. (2006). *A model for autumn pelagic distribution of adult female polar bears in the Chukchi Seas, 1987-1994*. (Contract Completion Report 70181-5-N240). Anchorage, Alaska: U.S. Geological Survey. p. 67.

Durner, G. M., Douglas, D. C., Nielson, R. M., Amstrup, S. C., McDonald, T. L., Stirling, I., . . . Derocher, A. E. (2009). Predicting 21st-Century Polar Bear Habitat Distribution from Global Climate Models. *Ecological Monographs, 79*(1), 25-58.

Elsner, R., Wartzok, D., Sonafrank, N. B., & Kelly, B. P. (1989). Behavioral and physiological reactions of Arctic seals during under-ice pilotage. *Canadian Journal of Zoology, 67*(10), 2506-2513.

Fischbach, A. S., Amstrup, S. C., & Douglas, D. C. (2007). Landward and eastward shift of Alaskan polar bear denning associated with recent sea ice changes. *Polar Biology, 30*(11), 1395-1405.

Fournet, M. E. H., Silvestri, M., Clark, C. W., Klinck, H., & Rice, A. N. (2021). Limited vocal compensation for elevated ambient noise in bearded seals: implications for an industrializing Arctic Ocean. *Proceedings of the Royal Society B: Biological Sciences, 288*(1945), 20202712. doi: doi:10.1098/rspb.2020.2712.

Frost, K. J. (1985). The ringed seal (*Phoca hispida*). In. Burns, J. J., Frost, K. J. & Lowry, L. F. (Eds.), *Marine Mammals Species Accounts*. Juneau, AK: Alaska Department of Fish and Game.

Garland, E. C., Berchok, C. L., & Castellote, M. (2015). Temporal peaks in beluga whale (*Delphinapterus leucas*) acoustic detections in the northern Bering, northeastern Chukchi, and western Beaufort Seas: 2010–2011. *Polar Biology*, 1-8.

Garner, G. W., Belikov, S. E., Stishov, M. S., Barnes, V. G., & Arthur, S. A. (1994). *Dispersal patterns of maternal polar bears from the denning concentration on Wrangel Island*. Paper presented at the International Conference on Bear Research and Management.

Garner, G. W., Knick, S. T., & Douglas, D. C. (1990). Seasonal movements of adult female polar bears in the Bering and Chukchi seas. *Paper presented at the International Conference on Bear Research and Management*

Ghazal, M. (2021). *Understanding ringed seal foraging ecology through Inuit knowledge and stomach content analysis.*

Gilday, M. M., Braithwaite II, K. J., & Berger, D. H. (2021). *a Blue Arctic*.

Götz, T., & Janik, V. M. (2010). Aversiveness of sounds in phocid seals: psycho-physiological factors, learning processes and motivation. *The Journal of Experimental Biology, 213*, 1536-1548.

Götz, T., Janik, V. M. G., T., & Janik, V. M. (2010). Aversiveness of sounds in phocid seals: psycho-physiological factors, learning processes and motivation. *The Journal of Experimental Biology, 213*, 1536-1548.

Gryba, R., Huntington, H. P., Von Duyke, A., Adams, B., Frantz, B., Gatten, J., . . . Skin, J. (2021). Indigenous Knowledge of bearded seal (*Erignathus barbatus*), ringed seal (*Pusa hispida*), and spotted seal (*Phoca largha*) behaviour and habitat use near Utqiaġvik, Alaska, USA. *Arctic Science, 7*(4), 832-858.

Halpin, P. N., Read, A. J., Fujioka, E., Best, B. D., Donnelly, B., Hazen, L. J., . . . Dimatteo, A. (2009). OBIS-SEAMAP: The world data center for marine mammal, sea bird, and sea turtle distributions. *Oceanography, 22*(2), 104-115.

Hamilton, C. D., Lydersen, C., Aars, J., Acquarone, M., Atwood, T., Baylis, A., . . . Boveng, P. (2022). Marine mammal hotspots across the circumpolar Arctic. *Diversity and Distributions*.

Hammill, M. O. (2008). Ringed seal *Pusa hispida*. In. Perrin, W. F., Wursig, B. & Thewissen, J. G. M. (Eds.), *Encyclopedia of Marine Mammals* (Second Edition ed., pp. 972-974). San Diego, CA: Academic Press.

Harris, R. E., Miller, G. W., & Richardson, W. J. (2001). Seal Responses to Airgun Sounds During Summer Seismic Surveys in the Alaskan Beaufort Sea. *Marine Mammal Science, 17*(4), 795-812.

Hastie, G. D., Donovan, C., Götz, T., & Janik, V. M. (2014). Behavioral responses by grey seals (*Halichoerus grypus*) to high frequency sonar. *Marine pollution bulletin, 79*(1-2), 205-210.

Hauser, D. D., Frost, K. J., & Burns, J. J. (2021). Ringed seal (*Pusa hispida*) breeding habitat on the landfast ice in northwest Alaska during spring 1983 and 1984. *Plos one, 16*(11), e0260644.

Heide-Jørgensen, M. P. (2009). Narwhal. In. Perrin, W. F., Wursig, B. & Thewissen, J. G. M. (Eds.), *Encyclopedia of Marine Mammals* (Second Edition ed.). San Diego, CA: Academic Press.

Holst, M., Stirling, I., & Hobson, K. A. (2001). Diet of ringed seals (*Phoca hispida*) on the east and west sides of the north water polynya, northern Baffin Bay. *Marine Mammal Science, 17*(4), 888-908.

Jefferson, T. A., Webber, M. A., & Pitman, R. L. (2008). Marine mammals of the world: A comprehensive guide to their identification. In (pp. 573). London, UK: Elsevier.

Jones, J. M., Thayre, B. J., Roth, E. H., Mahoney, M., Sia, I., Merculief, K., . . . Bacon, A. (2014). Ringed, bearded, and ribbon seal vocalizations north of Barrow, Alaska: Seasonal presence and relationship with sea ice. *Arctic, 67*(2), 203–222.

Kastak, D., & Schusterman, R. J. (1999). In-air and underwater hearing sensitivity of a northern elephant seal (Mirounga angustirostris). *Canadian Journal of Zoology, 77*, 1751-1758.

Kastelein, R. A., Wensveen, P. J., Hoek, L., & Terhune, J. M. (2009a). Underwater hearing sensitivity of harbor seals (Phoca vitulina) for narrow noise bands between 0.2 and 80 kHz. *Journal of the Acoustical Society of America, 126*(1), 476-483.

Kastelein, R. A., Wensveen, P. J., Hoek, L., Verboom, W. C., & Terhune, J. M. (2009b). Underwater detection of tonal signals between 0.125 and 100 kHz by harbor seals (Phoca vitulina). *Journal of the Acoustical Society of America, 125*(2), 1222-1229.

Kelly, B. P. (1988a). *Locating and characterizing ringed seal lairs and breathing holes in coordination with surveys using forward looking infra-red sensors* Fisheries and Oceans Freshwater Institute Final Report. p. 17.

Kelly, B. P. (1988b). Ringed Seal, *Phoca hispida*. In. Lentfer, J. W. (Ed.), *Selected Marine Mammals of Alaska: Species Accounts with Research and Management Recommendations* (pp. 57-75). Washington, D.C.: Marine Mammal Commission.

Kelly, B. P. (2022). The ringed seal: behavioral adaptations to seasonal ice and snow cover. In *Ethology and behavioral ecology of phocids* (pp. 553-597): Springer.

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

Kelly, B. P., Burns, J. J., & Quakenbush, L. T. (1988). *Responses of ringed seals (Phoca hispida) to noise disturbance.* Paper presented at the Symposium on Noise and Marine Mammals, Fairbanks, Alaska.

Kelly, B. P., Ponce, M., Tallmon, D. A., Swanson, B. J., & Sell, S. K. (2009). *Genetic diversity of ringed seals sampled at breeding sites; implications for population structure and sensitivity to sea ice loss*. University of Alaska Southeast, North Pacific Research Board 631 Final Report. p. 28.

Kelly, B. P., Quakenbush, L. T., & Rose, J. R. (1986). Ringed seal winter ecology and effects of noise disturbance. *Outer Continental Shelf Environmental Assessment*, 447-536.

Kovacs, K. M. (2017). Bearded seal: *Erignathus barbatus*. In *Encyclopedia of marine mammals* (pp. 83-86): Elsevier.

Kvadsheim, P. H., Sevaldsen, E. M., Folkow, L. P., & Blix, A. S. (2010). Behavioural and physiological responses of hooded seals (*Cystophora cristata*) to 1 to 7 kHz sonar signals. *Aquatic Mammals, 36*(3), 239-247.

Lentfer, J. W. (1972). *Alaska Polar Bear Research and Management, 1970-1971*. Alaska Department of Fish and Game. pp. 21-39.

Lønø, O. (1970). The polar bear (*Ursus maritimus* Phipps) in the Svalbard area.

Lowry, L. F., Frost, K. J., & Burns, J. J. (1980). Variability in the diet of ringed seals, *Phoca hispida*, in Alaska. *Canadian Journal of Zoology, 37*, 2254-2261.

Lydersen, C. (1998). Status and biology of ringed seals (*Phoca hispida*) in Svalbard. In. Heide-Jørgensen, M. P. & Lydersen, C. (Eds.), *Ringed Seals in the North Atlantic* (Vol. 1, pp. 46-62). Tromsø, Norway: NAMMCO Scientific Publications.

Lydersen, C., & Gjertz, I. (1986). Studies of the ringed seal (*Phoca hispida* Schreber 1775) in its breeding habitat in Kongsfjorden, Svalbard. *Polar Research, 4*(1), 57-63.

Lydersen, C., & Hammill, M. O. (1993). Diving in ringed seal (*Phoca hispida*) pups during the nursing period. *Canadian Journal of Zoology, 71*(5), 991-996.

Lydersen, C., Jensen, P. M., & Lydersen, E. (1990). A survey of the Van Mijen Fiord, Svalbard, as habitat for ringed seals, *Phoca hispida*. *Ecography, 13*(2), 130-133.

Lydersen, C., & Ryg, M. (1991). Evaluating breeding habitat and populations of ringed seals *Phoca hispida* in Svalbard fjords. *Polar Record, 27*(162), 223-228.

MacIntyre, K. Q., Stafford, K. M., Berchok, C. L., & Boveng, P. L. (2013). Year-round acoustic detection of bearded seals (*Erignathus barbatus*) in the Beaufort Sea relative to changing environmental conditions 2008-2010. *Polar Biology, 36*(8), 1161-1173.

McLaren, I. A. (1958). The biology of the ringed seal (*Phoca hispida* Schreber) in the eastern Canadian Arctic. *Fisheries Research Board of Canada, 118*, 97.

Møhl, B. (1968a). Auditory sensitivity of the common seal in air and water. *Journal of Auditory Research, 8*, 27-38.

Møhl, B. (1968b). Hearing in seals. In. Harrison, R. J., Hubbard, R., Rice, C. & Schusterman, R. J. (Eds.), *Behavior and Physiology of Pinnipeds* (pp. 172-195). New York: Appleton-Century.

Muto, M. M., Helker, V. T., Angliss, R. P., Allen, B. A., Boveng, P. L., Breiwick, J. M., . . . Zerbini, A. N. (2016). *Alaska marine mammal stock assessments, 2015*. (NOAA Technical Memorandum NMFS-AFSC-323). Seattle, WA. p. 300.

Muto, M. M., Helker, V. T., Delean, B., Young, N., Freed, J., Angliss, R., . . . Brost, B. (2021). Alaska marine mammal stock assessments, 2020.

Myrberg, A. A. (1981). Sound Communication and Interception in Fishes. In. Tavolga, W. N., Popper, A. N. & Fay, R. R. (Eds.), *Hearing and Sound Communication in Fishes* (pp. 395-452). New York: Springer-Verlag.

Myrberg, A. A., Jr. (1990). The Effects of Man-Made Noise on the Behavior of Marine Animals. *Environmental International, 16*, 575-586.

Nachtigall, P. E., Supin, A. Y., Amundin, M., Röken, B., Møller, T., Mooney, T. A., . . . Yuen, M. M. L. (2007). Polar bear Ursus maritimus hearing measured with auditory evoked potentials. *The Journal of Experimental Biology, 210*, 1116-1122.

NMFS Office of Protected Resources. (2018). *2018 revision to: Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (version 2.0): Underwater thresholds for onset of permanent and temporary threshold shifts*. National Oceanic and Atmospheric Administration Silver Spring, MD, USA.

NOAA National Centers for Environmental Information. (2022, September 22). Arctic Sea Ice Minimum Ties for Tenth Lowest Retrieved Retrieved September 22from https://nsidc.org/arcticseaicenews/2022/09/arctic-sea-ice-minimum-ties-tenth-lowest/ as accessed on February 23, 2023.

North Atlantic Marine Mammal Commission. (2004). *The ringed seal*. Tromso, Norway: North Atlantic Marine Mammal Commission (NAMMCO).

Nummela, S. (2008a). Hearing. In. Perrin, W. F., Wursig, B. & Thewissen, J. G. M. (Eds.), *Encyclopedia of Marine Mammals* (Second Edition ed., pp. 553-561). Burlington, MA: Academic Press.

Nummela, S. (2008b). Hearing in aquatic mammals. In. Thewissen, J. G. M. & Nummela, S. (Eds.), *Sensory Evolution on the Threshold* (pp. 211-224). Berkeley, CA: University of California Press.

NWF. (2023). Polar Bear Retrieved from https://www.nwf.org/Educational-Resources/Wildlife-Guide/Mammals/Polar-Bear

Olnes, J., Crawford, J., Citta, J., Druckenmiller, M., Von Duyke, A., & Quakenbush, L. (2020). Movement, diving, and haul-out behaviors of juvenile bearded seals in the Bering, Chukchi and Beaufort seas, 2014–2018. *Polar Biology, 43*, 1307-1320.

Owen, M. A., & Bowles, A. E. (2011). In-air auditory psychophysics and the management of a threatened carnivore, the polar bear (Ursus maritimus). *International Journal of Comparative Psychology, 24*(3), 244-254.

Owen, M. A., Swaisgood, R. R., Slocomb, C., Amstrup, S. C., Durner, G. M., Simac, K., & Pessier, A. P. (2015). An experimental investigation of chemical communication in the polar bear. *Journal of Zoology, 295*(1), 36-43.

Pagano, A. M., Durner, G. M., Atwood, T. C., & Douglas, D. C. (2021). Effects of sea ice decline and summer land use on polar bear home range size in the Beaufort Sea. *Ecosphere, 12*(10), e03768.

Palo, J. U. (2003). *Genetic diversity and phylogeography of landlocked seals*. Helsinki, Finland: University of Helsinki.

Palo, J. U., Makinen, H. S., Helle, E., Stenman, O., & Vainola, R. (2001). Microsatellite variation in ringed seals (*Phoca hispida*): Genetic structure and history of the Baltic Sea population. *Journal of Heredity, 86*, 609-617.

Polar Bears International. (2015). Home Range. *About Polar Bears* Retrieved from http://www.polarbearsinternational.org/habits-and-behavior/home-range as accessed on 8 July 2015.

Popper, A. N., Plachta, D. T. T., Mann, D. A., & Higgs, D. (2004). Response of Clupeid Fish to Ultrasound: A Review. *ICES Journal of Marine Science, 61*, 1057-1061.

Quakenbush, L., Bryan, A., Crawford, J., & Olnes, J. (2020). Biological monitoring of ringed seals in the Bering and Chukchi seas: Final Report to National Oceanographic and Atmospheric Administration, Award …. Retrieved

Reeves, R., Stewart, B., Clapham, P., & Powell, J. (2002). *National Audubon Society guide to marine mammals of the world*: Random House, New York.

Regehr, E. V., Amstrup, S. C., & Stirling, I. (2006). *Polar bear population status in the southern Beaufort Sea*: US Geological Survey Reston, Virginia, USA.

Reichmuth, C. (2008). Hearing in marine carnivores. *Bioacoustics, 17*(1-3), 89-92.

Richardson, W. J., Greene Jr., C. R., Malme, C. I., & Thomson, D. H. (1995). *Marine Mammals and Noise*. San Diego, CA: Academic Press.

Rode, K. D., Wilson, R. R., Regehr, E. V., St. Martin, M., Douglas, D. C., & Olson, J. (2015). Increased land use by Chukchi Sea polar bears in relation to changing sea ice conditions. *PloS one, 10*(11), e0142213.

Sills, J. M., Southall, B. L., & Reichmuth, C. (2015). Amphibious hearing in ringed seals (*Pusa hispida*): underwater audiograms, aerial audiograms and critical ratio measurements. *Journal of Experimental Biology*. doi: 10.1242/jeb.120972.

Simpkins, M. A., Hiruki-Raring, L. M., Sheffield, G., Grebmeier, J. M., & Bengston, J. L. (2003). Habitat selection by ice-associated pinnipeds near St. Lawrence Island, Alaska in March 2001. *Polar Biology, 26*, 577-586.

Smith, T. G. (1987). *The ringed seal, Phoca hispida, of the Canadian western Arctic*. Bulletin Fisheries Research Board of Canada. p. 81.

Smith, T. G., & Hammill, M. O. (1981). Ecology of the ringed seal, *Phoca hispida*, in its fast ice breeding habitat. *Canadian Journal of Zoology, 59*, 966-981.

Smith, T. G., Hammill, M. O., & Taugbøl, G. (1991). A review of the developmental, behavioural and physiological adaptations of the ringed seal, *Phoca hispida*, to life in the Arctic winter. *Arctic, 44*(2), 124-131.

Smith, T. G., & Lydersen, C. (1991). Availability of suitable land-fast ice and predation as factors limiting ringed seal populations, *Phoca hispida*, in Svalbard. *Polar Research, 10*(2), 585-594.

Smith, T. G., & Stirling, I. (1975). The Breeding Habitat of the Ringed Seal (Phoca hispida). The Birth Lair and Associated Structures. *Canadian Journal of Zoology, 53*, 1297-1305.

Southall, B. L., Bowles, A. E., Ellison, W. T., Finneran, J. J., Gentry, R. L., Greene Jr., C. R., . . . Tyack, P. L. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals, 33*(4), 411-521.

Southall, B. L., Finneran, J. J., Rcichmuth, C., Nachtigall, P. E., Ketten, D. R., Bowles, A. E., . . . Tyack, P. L. (2019). Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. *Aquatic Mammals, 45*(2), 125-232.

Southall, B. L., Nowacek, D. P., Bowles, A. E., Senigaglia, V., Bejder, L., & Tyack, P. L. (2021). Marine mammal noise exposure criteria: assessing the severity of marine mammal behavioral responses to human noise. *Aquatic Mammals, 47*(5), 421-464.

Stern, H. L., & Laidre, K. L. (2016). Sea-ice indicators of polar bear habitat. *The Cryosphere, 10*(5), 2027-2041.

Stirling, I., Lunn, N. J., & Iacozza, J. (1999). Long-Term Trends in the Population Ecology of Polar Bears in Western Hudson Bay in Relation to Climatic Change. *Arctic, 52*(3), 294-306.

Stirling, I., McDonald, T. L., Richardson, E. S., Regehr, E. V., & Amstrup, S. C. (2011). Polar bear population status in the northern Beaufort Sea, Canada, 1971—2006. *Ecological Applications, 21*(3), 859-876.

Stirling, I., Spencer, C., & Andriashek, D. (2016). Behavior and activity budgets of wild breeding polar bears (*Ursus maritimus*). *Marine Mammal Science, 32*(1), 13-37.

Terhune, J. M., & Ronald, K. (1971). The harp seal, Pagophilus groenlandicus (Erxleben, 1777). X. The air audiogram. *Canadian Journal of Zoology, 49*(3), 385-390.

Terhune, J. M., & Ronald, K. (1972). The harp seal, Pagophilus groenlandicus (Erxleben, 1777). III. the underwater audiogram. *Canadian Journal of Zoology, 50*(5), 565-569.

Terhune, J. M., & Ronald, K. (1976). The upper frequency limit of ringed seal hearing. *Canadian Journal of Zoology, 54*, 1226-1229.

U.S. Department of the Navy. (2021). *Final Environmental Assessment/Overseas Environmental Assessment for the Ice Exercise Program*.

U.S. Environmental Protection Agency. (2015). *EPA's Safer Choice Standard*. U.S. Environmental Protection Agency. p. 41.

U.S. Fish and Wildlife Service. (2014). Polar Bear Retrieved from http://www.fws.gov/alaska/fisheries/mmm/polarbear/facts.htm as accessed on 01 June 2015.

U.S. Fish and Wildlife Service. (2021a). *Polar Bear (Ursus maritimus): Chukchi/Bering Seas Stock*.

U.S. Fish and Wildlife Service. (2021b). *Polar Bear (Ursus maritimus): Southern Beaufort Sea Stock*.

Von Duyke, A. L., Douglas, D. C., Herreman, J. K., & Crawford, J. A. (2020). Ringed seal (*Pusa hispida*) seasonal movements, diving, and haul-out behavior in the Beaufort, Chukchi, and Bering seas (2011–2017). *Ecology and evolution, 10*(12), 5595-5616.

Wartzok, D., Elsner, R., Stone, H., Kelly, B. P., & Davis, R. W. (1992a). Under-ice movements and the sensory basis of hole finding by ringed and Weddell seals. *Canadian Journal of Zoology, 70*(9), 1712-1722.

Wartzok, D., Popper, A. N., Gordon, J., & Merrill, J. (2003). Factors affecting the responses of marine mammals to acoustic disturbance. *Marine Technology Society Journal, 37*(4), 6-15.

Wartzok, D., Sayegh, S., Stone, H., Barchak, J., & Barnes, W. (1992b). Acoustic tracking system for monitoring under-ice movements of polar seals. *Journal of the Acoustical Society of America, 92*, 682-687.

Wilson, R. R., & Durner, G. M. (2020). Seismic survey design and effects on maternal polar bear dens. *The Journal of Wildlife Management, 84*(2), 201-212.