U.S. Department of Homeland Security

United States Coast Guard

Polar Icebreaker Acquisition Program

Draft Programmatic Environmental Impact Statement

August 2018

U.S. Coast Guard Headquarters
2100 Second Street, SW
Washington, DC 20593-0001

Prepared by:
Naval Undersea Warfare Center
1176 Howell Street
Newport, RI 02841

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DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT
for
POLAR ICEBREAKER ACQUISITION PROGRAM

Lead Agency:	United States Coast Guard
Cooperating Agency:	None
Title of the Proposed Action:	Polar Icebreaker Acquisition Program
Designation:	Draft Programmatic Environmental Impact Statement

Abstract

The United States Coast Guard (Coast Guard) prepared this Programmatic Environmental Impact Statement (PEIS) to comply with the National Environmental Policy Act (NEPA) and Executive Order 12114. The Coast Guard identified its need to address the current mission demand and the long term projected increase in Coast Guard mission demand in polar regions. The current polar icebreaker fleet consists of two heavy and one medium icebreaker; however, the Coast Guard's heavy icebreakers have both exceeded their designed 30-year service life. The Proposed Action would allow the Coast Guard to recapitalize its polar icebreaker fleet to meet its mission requirements and ensure continued access to both polar regions and support the United States' economic, commercial, maritime and national security needs. Three Alternatives were analyzed.

- The No Action Alternative included use of the existing assets to fulfil Coast Guard missions, which are reaching the end of their service lives.
- Alternative 1 (Preferred Alternative) included the design and build up to six polar icebreakers to fulfill mission requirements in the Arctic and Antarctic.
- Alternative 2 included various forms of icebreaker leasing, such as those leases used by the United States Navy, the National Science Foundation, other federal agencies, and the domestic maritime industry, to close the Coast Guard icebreaking capability gap.

In this PEIS, the Coast Guard analyzed potential impacts on physical, biological, and socioeconomic environmental resources resulting from activities under the alternatives. Evaluated resources included: bottom habitat and sediment; sea ice; sound; marine vegetation; invertebrates; fish; essential fish habitat; seabirds; sea turtles; marine mammals; commercial and recreational fishing; research, transportation, shipping, and tourism; subsistence hunting; and, cultural resources.

[**Placeholder**: The Draft PEIS was released on [INSERT DATE]. The comment letters are reproduced in Appendix C and annotated with Coast Guard's specific responses to comments. Appendix D identifies the changes between the Draft and Final PEISs.]

Prepared by: United States Coast Guard

Point of Contact: United States Coast Guard
Attn: Polar Icebreaker Acquisition Program Manager
2700 Martin Luther King Jr. Avenue SE
Washington, D.C. 20593

EXECUTIVE SUMMARY

ES.1 Introduction

The United States Coast Guard (Coast Guard) is a military, multi-mission, maritime service within the Department of Homeland Security and one of the nation's five armed services. In executing its various missions, the Coast Guard protects the public, the environment, and United States (U.S.) economic and security interests in any maritime region, including international waters and the coasts, ports, and inland waterways of the United States, as required to support national security.

As the polar regions of the Arctic and Antarctic become more accessible, they become more important to U.S. and international interests. Polar icebreakers enable the Coast Guard to enforce treaties and other laws needed to safeguard both industry and the environment; provide ports, waterways and coastal security; provide logistical support; and, all other Coast Guard missions. Any increase in vessel traffic in the polar regions increases the potential for more search and rescue missions, water pollution, illegal fishing, and infringement on the U.S. Exclusive Economic Zone, which requires Coast Guard presence. In response to this potential surge in vessel traffic, a long term increase in Coast Guard mission demand is projected, thus requiring additional support from polar icebreaker vessels. The Proposed Action would allow the Coast Guard to meet the increasing demand in the polar regions, as well as year-round mission requirements.

This Programmatic Environmental Impact Statement (PEIS) was prepared in accordance with the National Environmental Policy Act (NEPA), as implemented by the Council on Environmental Quality (CEQ) Regulations (40 Code of Federal Regulations [CFR] §§ 1500 *et seq*.); Department of Homeland Security Directive Number 023-01; and Coast Guard Commandant Instruction M16475.1D and in compliance with other applicable laws, directives, executive orders, and the rights of federally recognized tribes. Executive Order (EO) 12114 (44 Federal Register 1957), *Environmental Effects Abroad of Major Federal Actions*, directs Federal agencies to be informed of and take account of environmental considerations when making decisions regarding major Federal actions outside of the United States, its territories, and possessions. Actions with the potential to significantly harm the global commons must be considered. Given the absence of any written Department of Homeland Security policy on how field units are to implement EO 12114, the analysis detailed in Section 10-3.19 of Naval Operations (OPNAV) M-5090.1 has been used to determine whether polar icebreaker operations occurring within the U.S. Territorial Sea will have transboundary effects on the environment and this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. In preparing this document, the Coast Guard assessed how operations and training activities associated with the polar icebreaker program acquisition strategy could potentially impact human and natural resources. Two alternatives and a No Action Alternative were considered. Coast Guard will issue a Record of Decision, once the Final PEIS is has been made publicly available for 30 days.

ES.2 Purpose and Need for the Proposed Action

The U.S. Coast Guard ensures the Nation’s maritime safety, security, and stewardship. However, a lack of infrastructure, polar environmental conditions, and vast distance between operating areas and support bases, all influence the Coast Guard’s ability to provide the same level of service and presence in the polar regions that Coast Guard provides in other non-polar areas of operation. Polar icebreakers are required to address current and future mission demands in the polar regions. The Coast Guard’s current polar icebreaking fleet includes two heavy icebreakers (Coast Guard Cutter [CGC] POLAR STAR and CGC POLAR SEA) and one medium icebreaker (CGC HEALY). The Coast Guard's heavy icebreakers have both exceeded their designed 30-year service life. CGC POLAR SEA has remained out of service since 2010 and is not expected to be reactivated. CGC POLAR STAR completed a service life extension in 2013, thus extending its service life to 2023. CGC HEALY will reach the end of its 30-year design service life in 2030. Therefore, Coast Guard proposes the design, build, and operation of up to six polar icebreakers (referred to as PIBs in this PEIS) to provide consistent and reliable presence in the polar regions. The Proposed Action would allow the Coast Guard to recapitalize its polar icebreaker fleet to meet its mission requirements and ensure continued access to both polar regions and support the United States' economic, commercial, maritime and national security needs. In addition, in support of the Coast Guard's science mission, an icebreaker would provide a unique platform of opportunity for scientists to conduct research in the polar regions.

ES.3 PROPOSED ACTION

The Coast Guard proposes the design and build of up to six polar icebreakers, each with a planned service life of 30 years. The Coast Guard also proposes to conduct polar icebreaker operations and training to meet Coast Guard mission responsibilities, in addition to vessel performance testing post-dry dock in the Pacific Northwest near the current homeport of Seattle, Washington1. Polar icebreakers are transcontinental vessels that would travel worldwide to support the Coast Guard's missions in the Antarctic and Arctic proposed action areas. Therefore, this PEIS also evaluated potential impacts from transiting vessels. However, because the first new Coast Guard PIB is not expected to be operational until 2023, the Coast Guard anticipates that supplemental NEPA documentation would be prepared in support of individual proposed actions, including specific information on homeport, maintenance schedules, decommissioning, and transit routes. Vessel construction is not expected to impact any physical or biological resources and is not analyzed in this PEIS.

The first of the newly constructed PIBs would be a heavy PIB to be commissioned as soon as 2023, the same year CGC POLAR STAR is scheduled to reach the end of its design service life. After the first PIB is constructed and commissioned into the Coast Guard fleet, up to five additional PIBs could be constructed and commissioned. It would take approximately 12–18 months to commission each subsequent PIB into the Coast Guard's polar icebreaker fleet. This schedule would allow for CGC POLAR STAR and CGC HEALY to be decommissioned as currently scheduled and for the Coast Guard to remain present, with no delay in service in the Arctic and Antarctic Regions, to complete the Coast Guard's missions.

Polar icebreaker operations and training would be expected after delivery of the first PIB. Because there are no anticipated significant changes to Coast Guard missions in the polar regions, this PEIS analyzes expected vessel operation and training activities based on the current Coast Guard fleet's operations and training activities conducted in the polar regions. Similar to the current fleet's operations, the Proposed Action would provide land/shore, air, and sea operations; training exercises; and, tribal and local government engagement, to meet the Coast Guard's mission responsibilities in the polar regions. To serve the public, the Coast Guard has organized responsibilities into six fundamental roles: (1) maritime safety/search and rescue; (2) national defense; (3) maritime security; (4) maritime mobility; (5) protection of natural resources, and 6) ice operations, where icebreakers play a key role.

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[1] The exact location for homeporting has not been determined, but the current fleet of polar icebreakers is homeported in Seattle, Washington.

One or more PIBs, as well as multiple support vessels, aircraft, and personnel deployed throughout the Antarctic and Arctic Regions would conduct PIB activities. Those activities pursue four main objectives:

1. perform Coast Guard missions and activities in the polar regions
2. advance Arctic maritime domain awareness
3. broaden partnerships
4. enhance and improve preparedness, prevention, and response capabilities

Table ES-1 provides a summary of Proposed Action activities and defines the proposed action area where that activity is expected to occur.

Table ES-1. Summary of Proposed Action Activities and Applicable Proposed Action Area(s)

Activity[1]	Proposed Action Area		
	Arctic	**Antarctic**	**Pacific Northwest**
Vessel Operations			
Icebreaking	x	x	
Maneuverability-Propulsion Testing			x
Maneuverability-Ice and Bollard Condition Testing	x		
Vessel Escort[2]	x	x	
Vessel Tow[2]	*	x	
Passenger Transfer	x	x	
Law Enforcement	x		
Search and Rescue Training[2]	x	x	
Scientific Support Missions[3]	x	x	
AUV Deployments	x		
Diver Training	x	x	x
Fueling Underway	x	x	
Gunnery Training	**		x[4]
Marine Environmental Response Training	x		x
Aircraft Operations			
Landing Qualifications	x	x	
Reconnaissance	x	x	
Vertical Replenishments and Mission Support	x	x	
Community Outreach and Passenger Transfer	x	x	

AUV: autonomous underwater vehicle

[1]Patrols encompass all activities listed below.

[2] Excluding the emergency response associated with these Proposed Action activities.

[3] Coast Guard personnel may participate in scientific surveys as part of the Coast Guard mission, but those activities would be covered under any required permits obtained by the researcher.

[4] Pacific Northwest, gunnery training would occur in the open ocean or on established U.S. Navy Ranges.

*Vessel towing in the Arctic is possible, but considered rare.

**Gunnery training could occur in the Bering Sea, but is considered rare due to weather limitations.

ES.4 Environmental Analysis and Mitigation

In accordance with CEQ guidance 40 CFR 1501.7(3), only resources that have the potential to be affected are discussed in this PEIS. Although the Coast Guard would work toward environmental compliance prior to the design and build of a PIB, the potential to impact the environment or biological resources would not occur until it is built, deployed, and operational. The first PIB may be operational as soon as 2023, and as such, the Coast Guard acknowledges that new information about the existing environment may become available before 2023, but after the publication of this PEIS. Therefore, the Coast Guard presents the best available information on the existing environment in this PEIS, but anticipates that there may be future supplemental environmental assessments tiered to this PEIS to support individual proposed actions and to analyze and include any new information. For example, it is anticipated that the Coast Guard would evaluate potential impacts from vessel homeporting, maintenance, decommissioning, and specific transit routes, once specific information about these elements are available.

Potential environmental stressors evaluated in this PEIS include acoustic (underwater acoustic transmissions, vessel noise, icebreaking noise, aircraft noise, and gunnery noise), and physical (vessel movement, aircraft or in-air device movement, in-water device movement, icebreaking, and military expended materials [MEM]) stressors. The potential environmental consequences of these stressors have been analyzed in this PEIS for resources associated with the physical, biological, and socioeconomic environments.

Because potential impacts were considered to be negligible or nonexistent, the following resources were not evaluated in this PEIS: air quality; airspace; floodplains and wetlands; geology; land use; terrestrial environment; water quality; wild and scenic rivers; deep sea corals and coral reefs; terrestrial wildlife; aesthetics; archaeological/historical resources; environmental justice; infrastructure; and, utilities.

The Proposed Action includes Standard Operating Procedures (SOPs) and Best Management Practices (BMPs) developed during federal and state agency permitting and approval processes, or as standard provisions for Coast Guard work. These SOPs and BMPs would be employed to avoid or minimize potential effects on the environment. Although SOPs and BMPs are established on a vessel-by-vessel basis, SOPs and BMPs currently in use by other icebreaking vessels would likely be used as guidance for any new PIB. Examples of SOPs and BMPs include avoidance of close approach to visible protected species and habitats; posting lookouts to alert vessels when a protected species is sighted to try and avoid areas where protected species are commonly observed.

ES.5 ALTERNATIVES CONSIDERED

Two alternatives in addition to the Proposed Action (Alternative 1, Preferred Alternative) were evaluated in this PEIS. Table ES-2 presents a summary of the potential impacts to evaluated resources associated and alternatives considered, including the No Action Alternative.

- **Alternative 1.** Proposed Action (Preferred Alternative). The design, build, and operations of up to six polar icebreakers.
- **Alternative 2.** Leasing. Considered various forms of vessel leasing, such as those leases used by the U.S. Navy, the National Science Foundation, other federal agencies, and the domestic maritime industry.
- **Alternative 3.** No Action. No new icebreakers would be built or leased and the Coast Guard would fulfill its missions in the Arctic and Antarctic using existing polar icebreaker assets.

ES.5.1 Summary of Environmental Analysis and Consequences (Preferred Alternative)

ES.5.1.1 Acoustic Stressors

The acoustic stressors from the Proposed Action include underwater acoustic transmissions (e.g., navigational technologies), vessel noise, icebreaking noise, aircraft noise, and gunnery noise. Potential acoustic impacts may include auditory masking (a sound interferes with the audibility of another sound that marine organisms may rely on), permanent threshold shift, temporary threshold shift, or a behavioral response. In general, the Coast Guard would use a medium or heavy PIB that would operate navigational technologies, including radar and sonar while underway. Marine species within the Arctic and Antarctic proposed action areas may also be exposed to icebreaking noise associated with a PIB's activities. In assessing the potential impact or harm to species from acoustic sources, a variety of factors were considered, including source characteristics, animal presence, animal hearing range, duration of exposure, and impact thresholds for those species that may be present. The Coast Guard evaluated the data and conducted an analysis of the species distribution and likely responses to the acoustic stressors based on available scientific literature. The Coast Guard also used specific methods, described below, to quantify potential effects to marine mammals from icebreaking. Icebreaking noise is generally described as a low frequency, 10 to 100 Hertz (Hz) (Roth et al. 2013), non-impulsive sound. Similarly, vessel noise is also characterized as low frequency. As such, a species response to icebreaking noise would be expected to be similar to their response to vessel noise. Therefore, non-marine mammal biological resources, such as seabirds, fish, and invertebrates that may potentially overlap with the proposed icebreaking area were not analyzed using the marine mammal modeling method because the model was developed only for marine mammals, so these resources were analyzed using qualitative methods, also described below. Sea turtles were not assessed for icebreaking sound exposure as their geographic ranges do not overlap any a proposed icebreaking areas.

Marine mammals are difficult to observe in real time and have varied behaviors based on species, geographic location, and time of year. Furthermore, field-based information on the effects of icebreaking on marine mammals is unavailable. Therefore, mathematical modeling was necessary to estimate the number of marine mammals that may be affected by icebreaking activities. The U.S. Department of the Navy (Navy) has invested considerable effort and resources analyzing the potential impacts of underwater sound sources (i.e., impulsive and non-impulsive sources on marine mammals and sea turtles). The Navy has used the Navy Acoustic Effects Model (NAEMO) since 1997 to model acoustic impacts to marine mammals. NAEMO has been refined since 1997 and documented in many environmental assessments and impact statements developed for Navy exercises. NAEMO was developed based on published research, collaboration with subject matter experts, and the Center for Independent Experts, an external peer-review system under the purview of NMFS. The Coast Guard used the Navy's NAEMO model to quantify the potential impacts on marine mammals from icebreaking associated with the Proposed Action. Based on modeling results, the following marine mammals exposed to icebreaking would be expected to elicit a behavioral reaction: Antarctic minke whale, Arnoux's beaked whale, bearded seal, blue whale, bowhead whale, crabeater seal, Gray's beaked whale, humpback whale, killer whale, leopard seal, minke whale, polar bear, ringed seal, Ross seal, southern bottlenose whale, and Weddell seal.

In general, if marine mammal, invertebrate, fish, bird, and sea turtle hearing ranges did not overlap with the frequency of the acoustic sources, further analysis was not conducted in this PEIS. If hearing ranges did overlap, the analysis in this PEIS considered the temporary nature of the Proposed Action and the current ambient noise levels in the proposed action areas, which all limited the exposure and impact from acoustic stressors to those species. Qualitative analyses of vessel noise and icebreaking noise were conducted similarly for all species groups, with the exception of marine mammals (NAEMO model used to analyze potential impacts from icebreaking noise), as they are both typically characterized as low frequency (less than 1 kilohertz and between 10 to 100 Hz, respectively) (Roth et al. 2013) acoustic sources. Qualitative analyses of potential impacts from exposure to aircraft noise considered in-air hearing ranges for exposed species (when known or a surrogate species was evaluated); the dominant tones in noise spectra from helicopters and fixed wing aircraft, as below 500 Hz (Richardson et al. 1995); and, evaluated both in-air and underwater exposure from the air-to-surface interface. Since the typical operating altitude for helicopters and unmanned aerial vehicles (UAVs) associated with the Proposed Action would be at or above 1,000 feet (305 meters), it was assumed that the received levels from aircraft would significantly decrease from the sound levels expected at the source.

ES.5.1.2 Summary of Impacts from Acoustic Stressors

Based on the analysis, impacts from acoustic sources associated with the Proposed Action are expected to result in, at most, minor to moderate behavioral responses over short and intermittent periods. Table ES-2 summarizes the potential acoustic impacts from acoustic stressors to fish, Essential Fish Habitat (EFH), invertebrates, marine mammals, seabirds, and sea turtles. Underwater acoustic transmissions, vessel noise, icebreaking noise, aircraft noise, and gunnery noise would not result in significant impact or result in significant harm to invertebrates, fish, essential fish habitat, birds, sea turtles, and marine mammals. Those species listed as endangered or threatened under section 7 of the Endangered Species Act (ESA), would not be expected to respond in ways that would significantly disrupt normal behavior patterns which include, but are not limited to: migration, breathing, nursing, breeding, feeding, or sheltering. Acoustic stressors from the Proposed Action would not cause population level effects to any ESA-listed species in the proposed action areas. Additionally, the Coast Guard would avoid all known critical habitat areas. For those species where authorizations or permits may be required, the Coast Guard would consult with the appropriate regulatory agency to ensure environmental compliance. The timing of this permit request would coincide more closely with the time the first PIB is operational, due to expected updates to information and potential changes to a species listing status.

ES.5.1.3 Physical Stressors

Vessels and aircraft associated with the Proposed Action would be widely dispersed throughout the proposed action areas. The physical stressors from the Proposed Action include vessel movement, aircraft movement, autonomous underwater vehicle (AUV) movement, icebreaking, and MEM. The physical presence of aircraft and vessels could lead to behavioral reactions from visual or auditory cues. In assessing the potential impact or harm to species from physical sources, a variety of factors were considered, including vessel and operation characteristics, animal presence, and likelihood of exposure. The Coast Guard evaluated the data and conducted an analysis of the species distribution and likely responses to the physical stressors based on available scientific literature. Reactions to vessels often include changes in general activity (e.g., from resting or feeding to active avoidance), changes in surface respiration or dive cycles (marine mammals), and changes in speed and direction of movement. The severity and type of response exhibited by an individual may also include previous encounters with vessels. Some species have been noted to tolerate slow-moving vessels within several hundred meters, especially when the vessel is not directed toward the animal and when there are no sudden changes in direction or engine speed (Richardson et al. 1995). In addition, vessels and aircraft could collide with resources found in all proposed action areas.

This PEIS considered vessel movement, including vessel tow training, when evaluating the potential impacts of vessel movement on resources in the proposed action areas. In general, short-term and localized disturbances are anticipated. The likelihood that an individual would interact with the vessel tow cable and become entangled is low because the tow lines would have no loops or slack, thereby reducing the likelihood of entanglement. Although the tow cable and towed vessel may impact or harm fish, birds, and marine mammals encountered along a tow route, the chance that such an encounter would result in serious injury is extremely remote because of the low probability that an individual of a species would overlap with the infrequent tow training events.

Potential collision of vessels with biological resources was also considered in the analysis of vessel movement. The likelihood that a vessel would strike an invertebrate or a fish is extremely low because vessel movement would either avoid areas where these organisms are found or animals would be expected to avoid the vessel itself. The probability of a seabird colliding with a vessel would increase at night and in situations of poor visibility; however, the likelihood of a vessel collision with a bird is extremely low because a PIB would likely operate farther offshore than where the majority of birds would be expected; a PIB would only operate navigational safety lights at night that would not be expected to attract birds; and during times of reduced visibility, a vessel would likely reduce vessel speeds for navigational safety. Flightless birds, including penguins and molting birds, would also be susceptible to a vessel collision; however, the Coast Guard’s SOPs and BMPs would minimize potential impacts. Sea turtles are also known to be attracted to lights, but similar to birds, the navigational safety lights would not be expected to act as an attractant to sea turtles.

Marine mammal species most vulnerable to collision are thought to be those that spend extended periods at the surface or species whose unresponsiveness to vessel sound makes them more susceptible to vessel collisions. Although the maximum speed of the icebreaker during vessel propulsion testing is 12–17 knots, a PIB is expected to operate at slower speeds during most of the Proposed Action activities. While slower speeds could decrease the chance of a fatal collision, it will not eliminate the risk of a collision. In addition, any vessel collision has the chance of causing serious injury or mortality, should it occur. However, the Coast Guard’s SOPs and BMPs, in addition to the slow vessel speeds, would decrease the risk of a collision with a marine mammal.

AUV movement could impact biological resources, including invertebrates, fish, seabirds, and marine mammals; however, the potential for an AUV to strike individuals is similar to that identified for vessels in the analysis. Any animal that was displaced would be expected to resume normal activities due to the short-term and localized nature of the disturbance. Collision risk with an AUV is considered to be extremely low.

With the exception of birds, no other biological resources are expected to interact with aircraft, so they were not assessed. The aircraft used during the Proposed Action would be the MH-60 Jayhawk helicopter and UAVs for ice reconnaissance. Birds would be most at risk of a strike during takeoff and landing because the helicopter is passing through the lower altitudes where birds may be found. Bird strikes are a serious concern for helicopter crews not only because of the risk to the birds, but also because they can harm aircrews and equipment. For this reason, Coast Guard would avoid large flocks of birds to increase personnel safety and minimized any risk associated with a bird-aircraft strike and would follow SOPs and BMPs and avoid critical habitat areas and areas where there are known gatherings of seabirds. While there is some risk of an aircraft-seabird strike associated with the Proposed Action, the risk of a strike is low. Should a collision occur, bird mortality or injuries due to the strike caused by helicopter or UAV movement may result, but population level impacts to seabirds are not expected.

Icebreaking would occur in the Arctic and Antarctic proposed action areas at speeds of 3 to 6 knots. It has the potential to impact or harm marine species by altering habitats, causing behavior reactions, or colliding with resources. There would be no impacts to sea turtles as they are not found in the icebreaking areas. Marine vegetation living under ice may encounter short-term and localized disturbances from icebreaking; however, no long-term or population level effects are expected as the amount of biomass that would potentially be impacted or harmed is insignificant relative to the overall biomass of the system. Due to the low speed of the icebreaker during icebreaking operations, it is expected that fish species, along with seabirds and marine mammals, would exhibit temporary behavioral responses to the presence of icebreaking. Icebreaking is not expected to significantly alter Arctic cod ice floe habitat, the only EFH that has the potential to overlap with potential icebreaking areas. In the Antarctic proposed action area, Adélie penguins breed on land, and emperor penguins breed in the austral autumn; however, neither species would be exposed to icebreaking operations in the austral summer, when most icebreakimg in the Antarctic is expected to occur. For marine mammal species, because the noise associated with icebreaking activities is most likely to result in marine mammals avoiding the icebreaking vessel or area for a short period, it is highly unlikely that a PIB would strike a marine mammal or cause any physical harm. However, pinnipeds and polar bears that haul out on the ice may be more susceptible to icebreaking impacts. Icebreaking may result in localized changes to the polar bear and proposed ringed seal critical habitat as larger sheets of floating ice are broken down into smaller sizes. However, icebreakers do not diminish or destroy ice habitat because the amount of ice that is broken up relative to the overall total amount of available ice is small. Since the impact would be limited only to the area directly in the path of the icebreaking vessel, short-term and localized disturbances would be expected and any animal that was displaced would be expected to resume normal activities after any brief disturbance.

MEM were assessed, including ingestion of MEM by marine species, when evaluating the potential impacts of gunnery training activities on resources in the proposed action areas. MEM from gunnery training activities would include targets, target fragments, and inert small caliber projectiles that would not be recovered. Most likely, the targets used would drift with currents until popping, then sink through the water column and end up on the seafloor. Impacts on soft bottom habitats from small caliber projectiles would be short term, as these are constantly moving and shifting. It is anticipated that, over time, projectiles could become colonized by invertebrates, thus, becoming part of the bottom habitat. Due to the short-term impact of MEM on the seafloor, MEM is not anticipated to adversely affect the quality or quantity of EFH. Although unlikely, small pieces of MEM may be ingested by an organism; however, targets and target fragments left as expended material are not in high enough densities to cause population level impacts.

ES.5.1.4 Summary of Impacts from Physical Stressors

Based on the analysis, impacts from physical stressors associated with the Proposed Action are expected to result in, at most, minor to moderate behavioral responses over short and intermittent periods. Table ES-2 summarizes the potential impacts from physical stressors to fish, EFH, invertebrates, marine mammals, birds, and sea turtles. Devices associated with the Proposed Action with a potential for entanglement include the lines used in vessel tow. For an organism to become entangled in a line or material, the materials must have certain properties, such as the ability to form loops and a high breaking strength. Towing lines would not be expected to have any loops or slack. The likelihood that a biological resource would become entangled in tow lines is extremely low. Vessel movement, aircraft movement, AUV movement, icebreaking, and MEM would not result in significant impact or result in significant harm to bottom habitat and sediment, marine vegetation, invertebrates, fish, EFH, birds, sea turtles, and marine mammals.

Those species listed as endangered or threatened under section 7 of the ESA, would not be expected to respond in ways that would significantly disrupt normal behavior patterns which include, but are not limited to: migration, breathing, nursing, breeding, feeding, or sheltering. Physical stressors from the Proposed Action would not cause population level effects to any ESA-listed species in the proposed action areas. The Coast Guard would avoid all known critical habitat areas. However, the Proposed Action includes ice breaking and ice is a physical and biological feature essential to the conservation of ESA-listed species. Thus, during icebreaking, the Proposed Action would not alter the physical or biological features essential to the conservation of ESA-listed species, including ringed seal and polar bear sea ice habitat. For those species where authorizations or permits may be required, the Coast Guard would consult with the appropriate regulatory agency to ensure environmental compliance. The timing of this permit request would coincide more closely with the time the first PIB is operational, due to expected updates to information and potential changes to a species listing status.

ES.5.1.5 Socioeconomic Impacts

Commercial fishing, recreational fishing, research, transportation and shipping, tourism, and subsistence hunting and cultural resources are the socioeconomic resources that would be impacted by the Proposed Action. The predominant socioeconomic impact of a PIB would be an increased Coast Guard presence in the proposed action areas and the Coast Guard's jurisdictional areas. Replacement of the ageing Coast Guard's polar icebreaker fleet would facilitate the Coast Guard's ability to support the Coast Guard mission including law enforcement, provide consistent search and rescue capabilities, and support on-going research operations.

ES.5.1.6 Summary of Impacts to Resource Areas

An increase in the Coast Guard icebreaking fleet would be beneficial, and any potential negative impacts caused by the Coast Guard's presence and operations and training would be mitigated by the implementation of SOPs and BMPs. Additionally, outreach and educational programs conducted by the Coast Guard within the proposed action areas would facilitate communication between Coast Guard and the communities that they serve. More readily available Coast Guard support during an at-sea emergency is the principal benefit from the Proposed Action to commercial fishing, recreational fishing, transportation and shipping, tourism, and cultural resources and the communities that depend on them.

ES.5.1.7 Mitigation

The results of the analysis indicate that, with the implementation of SOPs and BMPs, the Proposed Action would not significantly impact or harm the physical, biological, and socioeconomic environments.

ES.5.2 Alternative 2: Leasing of Polar Icebreaker Vessels

This analysis includes consideration of pre-determined, fixed-price, long-term leasing arrangements, demise charters (i.e., bareboat), and contractor-owned, contractor-operated charters. The leasing alternative was analyzed in detail through previous studies, first in the early 1980s and again in 2011 (Schnappinger and ABS Consulting 2011). This analysis re-visited the leasing option to investigate whether any of the underlying conditions had changed. The investigation revealed that the previous conditions that were analyzed had not changed. As such, this alternative would not meet the purpose and need, but is included here for comparison of environmental effects with the Preferred Alternative. Those principle reasons that remain unchanged are:

- There are no existing vessels available for lease that substantially meet the Operational Requirements Document requirements.
- Office of Management and Budget guidance mandates that a Capital Lease would be required for a purpose such as this alternative. As a Capital Lease, both Office of Management and Budget guidance and U.S. Code would require that the lease be a demise charter due to the missions the Coast Guard must execute with the vessel, including planned operations in support of defense readiness and mission tasks involving law enforcement and port, waterways, and coastal security.
- In addition, under international law and U.S. Code, the vessel would need to be on a demise charter to the Coast Guard in order for a leased vessel to be authorized to conduct National Defense and Freedom of Navigation operations, which require the vessel to be internationally recognized as a warship.

ES.5.3 Alternative 3: No Action Alternative

The evaluation of a No Action Alternative is required by the regulations implementing NEPA (40 CFR 1502.14(d)). Under the No Action Alternative, the Coast Guard would fulfill its missions in the Arctic and Antarctic using existing polar icebreaker assets, which are reaching the end of their service lives. The existing assets would continue to age, causing a decrease in efficiency of machinery as well as an increased risk of equipment failure or damage, and would not be considered reliable for immediate emergency response. In addition, it may become more difficult for an ageing fleet to remain in compliance with environmental laws and regulations and standards for safe operation.

The No Action Alternative would also not meet the Coast Guard's statutory mission requirements in the Arctic or Antarctic by providing air, surface, and shoreside presence in the polar regions. The Coast Guard also enforces the Marine Mammal Protection Act (MMPA) and ESA, and without reliable Coast Guard presence, enforcement of these laws would be significantly reduced. As such, this alternative would not meet the purpose and need, but is included here for comparison of environmental effects with the Preferred Alternative.

ES.6 Cumulative Impacts

The Coast Guard's mission to protect living marine resources and the environment, provide law enforcement, conduct search and rescue operations, and train to respond to large oil spills would help to prevent environmental damage and protect the proposed action areas; has beneficial effects in the Arctic, Antarctic, and Pacific Northwest proposed action areas. PIBs may contribute to cumulative effects in the acoustic environment, but the potential impacts to marine species, and their habitat including prey availability/distribution, are expected to be minimal and temporary based on the sound produced by Coast Guard assets in polar regions (including icebreaking, small boats, and any associated aircraft operations) when compared to the many vessels and aircraft, as well as commercial, government, and research operations in the proposed action areas analyzed. Furthermore, the use of the SOPs and BMPs would further reduce any impacts, particularly impacts to marine species, or to sensitive biological and critical habitats.

ES.7 Public Involvement

Communication methods used by the Coast Guard to distribute the proposed project information to residents of Alaska included: radio, newspapers, fliers, electronic mail, and Web sites. Public presentations of the Proposed Action, and preliminary findings provided at public meetings held in Alaska, were advertised with fliers and newspaper postings, as well as in radio announcements, and social media.

A project website was established to facilitate public input within and outside the Arctic, Antarctic and Pacific Northwest regions (http://www.dcms.uscg.mil/Our-Organization/Assistant-Commandant-for-Acquisitions-CG-9/Programs/Surface-Programs/Polar-Icebreaker/). The scheduling of public meetings was publicized in press releases available on the Coast Guard's website and in the Federal Register Notice (83 Federal Register 18319; 26 April 2018). Public meetings were held in Nome (May 7, 2018), Kotzebue (May 9, 2018), Anchorage (May 11, 2018), and in Barrow/Utqiagvik (May 14, 2018). A Notice of Availability and request for comments [INSERT DATE] was publicized in the Federal Register Notice [INSERT DATE] to notify the public of the 45-day public review period for the Draft PEIS.

Placeholder: *This section is incomplete because the Coast Guard intends to conduct a 45-day public comment period on the Draft PEIS and will update this section before the Final PEIS is completed.*

ES.8 Compliance with other Applicable laws, Policies, and Directives

In accordance with NEPA and EO 12114, the Coast Guard has prepared this PEIS, assessing the environmental impact of and alternatives to a major federal action that has the potential to significantly affect the environment within the U.S. Exclusive Economic Zone and extending to the high seas. The Coast Guard has prepared this PEIS based on international, federal, state, and local laws, statutes, regulations, and policies that are pertinent to the implementation of the Proposed Action. A summary regarding the ESA, MMPA, Magnuson-Stevens Fishery Conservation and Management Act, are provided below.

ES.8.1 Endangered Species Act

The Coast Guard consulted with United States Fish and Wildlife Service (USFWS) and NMFS for those species under their respective jurisdictions, under section 7 of the ESA. On [INSERT DATE], NMFS concurred with the Coast Guard's finding that the Proposed Action may affect, but is not likely to adversely affect ESA-listed species and proposed or designated critical habitat that fall under their jurisdiction. Similarly, the USFWS concurred on [INSERT DATE], with the Coast Guard's finding that the Proposed Action may affect, but is not likely to adversely affect ESA-listed species or candidate species and proposed or designated critical habitat that fall under their jurisdiction. However, the Coast Guard recognizes that new information regarding the Proposed Action and biological resources in the proposed action area may change before the first icebreaking vessel is operational (as soon as 2023). The Coast Guard will continue to coordinate with both regulatory agencies and if necessary, reconsult under section 7 of the ESA if there are any changes in the Proposed Action or biological resources in the Proposed Action Area.

Placeholder: This section is incomplete because the Coast Guard has not completed the consultation process. Consultations would be completed before issuance of the Final PEIS.

ES.8.2 The Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972, as amended (16 United States Code [U.S.C.] 1361 et seq.) prohibits, with certain exceptions, the take of marine mammals in U.S. waters and by U.S. citizens on the high seas and the importation of marine mammals and marine mammal products. Coast Guard Instruction [CGD17INST] 16214.2A (U.S. Coast Guard 2011) outlines procedures for avoiding marine mammals and protected species; reporting marine mammal and protected species sightings, strandings and injuries; and enforcing the MMPA and ESA. The Coast Guard is not requesting authorization under Section 101(a)(5) of the MMPA at this time, because the Proposed Action discussed in this PEIS would not deliver the first operational icebreaker until 2023; however, this PEIS may contain information relevant and applicable to assist with future Coast Guard consultations that are in support of a request for future incidental take authorizations under the MMPA. As part of the MMPA, the Coast Guard intends to prepare a Plan of Cooperation that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses.

ES.8.3 Magnuson-Stevens Fishery Conservation and Management Act

Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act requires Federal action agencies to consult with NMFS on all actions or Proposed Actions authorized, funded, or undertaken by the agency that may adversely affect EFH. The Coast Guard determined that all activities of the Proposed Action would have no significant adverse effect on designated EFH.

ES.9 CONCLUSION

The Proposed Action supports the Coast Guard's design and build of up to six polar icebreakers with service design lives of 30 years each. This would provide consistent and reliable Coast Guard presence in the Arctic and Antarctic to fulfill the Coast Guard's missions, guided by the Coast Guard's Arctic Strategy and Arctic Strategy Implementation Plan (with direction from the President of the United States), the National Security Strategy, National Military and Maritime Strategies, National Strategy for the Arctic Region, Arctic Region Policy National Security Presidential Directive 66/Homeland Security Presidential Directive 25, National Strategies for Homeland Security, and Maritime Domain Awareness, National Ocean Policy, and EO 13580.

This PEIS is consistent with the requirements of NEPA (42 U.S.C. 4321), and CEQ regulations for implementing NEPA (40 CFR Part 1500). Scoping for preparation of the Draft PEIS and public commenting on the Draft PEIS were used to obtain input from stakeholders, including individuals, public interest organizations, government agencies, and tribes. This input was used to develop the alternatives and issues analyzed in this PEIS. On the basis of the analyses in this PEIS, the types of impacts that could occur during routine operations and training activities would be similar among the action alternatives. The alternatives differ principally on the basis of vessel acquisition.

The Coast Guard evaluated acoustic stressors, including acoustic sources, vessel noise, icebreaking noise, aircraft noise, and gunnery noise. This Coast Guard also evaluated physical stressors of the Proposed Action, including vessel and aircraft movement; icebreaking; and military expended materials. Any potential environmental impacts would be temporary or short term and the Coast Guard's SOPs and BMPs would appropriately and reasonably reduce the potential environmental impacts resulting from the Proposed Action. In the analysis of stressors, it was concluded that the Proposed Action is not likely to significantly impact or result in significant harm to the physical, biological, or socioeconomic environment, including marine vegetation, invertebrates, seabirds, sea turtles, fish, Essential Fish Habitat, marine mammals, and socioeconomic resources. Pursuant to section 7 of the ESA, the Coast Guard determined that the Proposed Action is may affect, but is not likely to adversely affect the following species under NMFS' and the USFWS' jurisdiction: the ESA-listed bearded seal, blue whale, bocaccio, bowhead whale, Chinook salmon, chum salmon, coho salmon, fin whale, gray whale, humpback whale, leatherback sea turtle, marbled murrelet, North Pacific right whale, Pacific eulachon, polar bear, ringed seal, sei whale, sockeye salmon, Southern Resident killer whale, spectacled eider, sperm whale, short-tailed albatross, steelhead trout, Steller's eider, Steller sea lion, or yelloweye rockfish.

Pursuant to section 7 under the ESA, acoustic transmissions, vessel noise, aircraft noise, icebreaking noise, and gunnery noise associated with the Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat of the Steller's eider, spectacled eider, North Pacific right whale, polar bear, Southern Resident killer whale, Steller sea lion, or proposed ring seal critical habitat. No other critical habitat overlaps the proposed action areas; therefore, there will be no effect to critical habitat outside of the Arctic and Pacific Northwest proposed action areas. Based on the information and analyses included in this PEIS on the past, present, and reasonably foreseeable future actions within the proposed action areas, the Coast Guard has determined that the proposed PIB activities in the Arctic, Antarctic, and Pacific Northwest would not be expected to significantly contribute to the cumulative impacts on marine species, critical habitat, the environment, or socioeconomics.

PIBs may contribute to cumulative effects in the acoustic environment, but the potential impacts to marine species, and their habitat including prey availability/distribution, are expected to be minimal and temporary based on the sound produced by polar icebreaking ships (including icebreaking, small boats, and any associated aircraft operations) when compared to the many vessels and aircraft, as well as commercial, government, and research operations in the proposed action areas analyzed above. Furthermore, the use of the SOPs and BMPs would further reduce any impacts, particularly impacts to marine species, or to sensitive biological and critical habitats. Based on the information and analyses provided above on the past, present, and reasonably foreseeable future actions within the proposed action areas, the Coast Guard has determined that the proposed PIB activities in the Arctic, Antarctic, and Pacific Northwest would not be expected to significantly contribute to the cumulative impacts on marine species, critical habitat, the environment, or socioeconomic resources.

Table ES-2. Summary of Potential Impacts to Resources under each Alternative Considered

<table>
<tr><th>Resource</th><th>Alternative 1</th><th>Alternative 2: Leasing</th><th>Alternative 3: No Action</th></tr>
<tr><td colspan="4">Physical Environment</td></tr>
<tr><td>Bottom Habitat and Sediment</td><td colspan="2">Settling of MEM on the seafloor from gunnery training could impact marine habitats by creating localized disturbance of the seafloor, craters of soft bottom sediments, or structural damage to hard bottom habitats. MEM that settles in the shallower, more dynamic environments of the continental shelf would likely be covered over by sediments due to currents and other coastal processes. No significant impact or significant harm is expected in the Arctic or Pacific Northwest proposed action areas. There would be no impact or harm to bottom habitat or sediment in the Antarctic proposed action area because no gunnery training would occur there.</td><td>No change to environmental baseline*.</td></tr>
<tr><td>Sea Ice</td><td colspan="2">Potential impacts or harm to sea ice may occur in the Arctic or Antarctic proposed action areas. The Proposed Action may modify sea ice through icebreaking by creating open water paths through sea ice. However, relative to the amount of sea ice present, icebreakers impact a very small amount of change to ice cover (e.g., one part per mission of the total ice cover**). Thus, icebreaking may result in localized changes to sea ice’ however, icebreakers would not diminish or destroy ice habitat because the amount of ice that is broken up relative to the overall total amount of ice is small. No significant impact or significant harm to sea ice is expected in the Arctic or Antarctic proposed action areas. There would be no impact or harm to sea ice as in the Pacific Northwest proposed action area because sea ice is not present and no icebreaking would occur.</td><td>No change to environmental baseline*.</td></tr>
<tr><td colspan="4">Biological Environment</td></tr>
<tr><td>Marine Vegetation</td><td colspan="2">MEM may sink to the bottom during gunnery training, but any impacts to marine vegetation, if present, would be temporary. A PIB would also not set the anchor in areas where marine vegetation is likely to occur in the proposed action areas. No significant impacts or significant harm to marine vegetation is expected in all proposed action areas.</td><td>No change to environmental baseline*.</td></tr>
<tr><td>Invertebrates</td><td colspan="2">Vessel and icebreaking noise, if perceived by an invertebrate, would likely result in avoidance behavior or other short term temporary responses, but would not result in any population level impact or harm. Vessel and AUV movement have the potential to impact or harm marine invertebrates either by disturbing the water column or directly striking the organism, if it is present on or near the ice. Although unlikely, invertebrates could be killed or displaced during icebreaking. Because the impact would be localized to the immediate path of a PIB, icebreaking disturbance would not be expected to have population level impacts. Vessel noise, icebreaking noise, vessel movement, AUV movement, and icebreaking, would not result in significant impact or result in significant harm to invertebrates in all proposed action areas.</td><td>No change to environmental baseline*.</td></tr>
</table>

Resource	Alternative 1	Alternative 2: Leasing	Alternative 3: No Action
Fish	Underwater acoustic transmissions, vessel noise, icebreaking noise, and icebreaking would likely result in short-term and insignificant behavioral reactions or avoidance behavior, and thus, would not be expected to have any population level impacts. AUV and vessel movement may result in short-term and local displacement of fish in the water column. Although unlikely, small pieces of MEM from gunnery training and small caliber practice munitions may be ingested by an individual. Vessel noise, icebreaking noise, vessel movement, AUV movement, icebreaking, and MEM, would not result in significant impacts or significant harm to fish in all proposed action areas.		No change to environmental baseline*.
EFH	Acoustic transmissions could increase in ambient sound level; however, this potential reduction in the quality of the acoustic habitat would be localized and temporary. Icebreaking associated with the Proposed Action may affect the quality or quantity of Arctic cod EFH; however, the effects of icebreaking on Arctic cod EFH would be minimal, due to the small area of icebreaking as compared to the overall quantity of ice floe habitat. MEM impacts on soft bottom habitats would be short term, as sediments are constantly moving and shifting. Underwater acoustic transmissions, icebreaking, and MEM would not result in significant impact or significant harm to EFH in the Arctic and Pacific Northwest proposed action areas. No EFH is designated in the Antarctic proposed action area.		No change to environmental baseline*.
Seabirds	Vessel noise, icebreaking noise, vessel movement, and icebreaking would likely result in temporary behavioral responses. Any increase in ambient noise as a result of icebreaking or vessel movement would be temporary and localized to the position of the vessel as it transits or when icebreaking. Aircraft noise and gunnery noise may elicit, at most, short-term behavioral or physiological responses to exposed birds, such as an alert or startle response, or temporary increase in heart rate. While there is some risk of an aircraft-seabird strike, due to Coast Guard mitigation measures (e.g., limited duration of aerial operations); and avoidance of aircraft by seabirds, the risk of a strike is low. The potential for a bird strike by the AUV is extremely low, given the limited amount of time seabirds spend in the water relative to the air and low likelihood a diving seabird would overlap with AUV routes. Because of the small number of gunnery training targets, and the distance at which targets would be dispersed in the Arctic and Pacific Northwest proposed action areas, target and target fragments would not present a significant threat to seabird populations. Vessel noise, icebreaking noise, aircraft noise, gunnery noise, vessel movement, aircraft movement, AUV movement, icebreaking, and MEM would not result in significant impact or significant harm to seabirds.		No change to environmental baseline*.

Resource	Alternative 1	Alternative 2: Leasing	Alternative 3: No Action
Sea Turtles	Vessel noise in the open ocean may cause a startle response in sea turtles; however, any response is expected to be short term and temporary. Vessel noise from a PIB would not be expected to impact a sea turtle's ability to perceive other biologically relevant sounds. Although sea turtles would likely hear and see approaching vessels, a risk of a vessel collision with a sea turtle exists; however, sea turtles spend most of their time submerged, which would reduce their risk of a vessel collision. Vessel noise and vessel movement would not result in significant impact or result in significant harm to sea turtles in the Pacific Northwest proposed action area or in the Arctic proposed action area (although the leatherback sea turtle is considered extralimital). Aircraft movement, aircraft noise, icebreaking, and icebreaking noise would have no significant impact or significant harm on sea turtles as sea turtles would not overlap in areas where aircraft operations and icebreaking are expected.		No change to environmental baseline*.
Marine Mammals	Acoustic transmissions and icebreaking noise, may result in minor to moderate behavioral responses to exposed individuals, but the behavioral response is expected to be temporary. Vessel noise may elicit a minor behavioral response by exposed individuals. Any noise generated by the UAV is expected to be minimal and below the hearing threshold of marine mammals, both in air and underwater. The noise from the UAV is not expected to penetrate below the water's surface; however, in the unlikely event that a marine mammal is exposed to UAV noise underwater, any behavioral response is expected to be very minor. The probability of a vessel encountering a marine mammal is expected to be low, decreasing the risk of a PIB-marine mammal collision. The risk of a collision between an AUV moving through the water and a marine mammal is extremely low. It is expected that icebreaking noise would alert marine mammals to the presence of a PIB before icebreaking would overlap with a marine mammal. Therefore, due to the expected avoidance behaviors caused by icebreaking noise; the likelihood that a PIB would collide with a marine mammal during icebreaking is extremely low. Pinnipeds or polar bears that may be observed on the surface of the ice may be more susceptible to impacts caused by icebreaking, but avoidance responses are also expected, and SOPs and BMPs, such as trained Coast Guard lookouts, would minimize any potential impacts. During the Arctic summer months, from May to September, pupping would not occur and subnivean lairs would not be occupied. Icebreaking would only occur when needed and based on historical icebreaking, the majority occurs during the summer months. Therefore, the likelihood that a PIB would impact a subnivean lair is low. MEM has the potential to impact or harm marine mammal species that feed on the bottom, if ingested, but the likelihood that a marine mammal would ingest MEM is extremely low. The Proposed Action is not expected to cause abandonment of breeding or avoidance of breeding areas, disruption of migration or feeding, or significant disruption to pinniped haul outs. Underwater acoustic transmissions, vessel noise, icebreaking noise, aircraft noise, vessel movement, AUV movement, icebreaking, and MEM would not result in significant impact or significant harm to marine mammals.		No change to environmental baseline*.

Resource	Alternative 1	Alternative 2: Leasing	Alternative 3: No Action
Socioeconomic Environment			
Commercial and Recreational Fishing,	The Proposed Action would positively impact all the proposed action areas through Coast Guard law enforcement (e.g., illegal fishing), national security activities, and maritime safety/search and rescue. The Proposed Action would not result in significant negative impacts or significant harm to commercial or recreational fishing.		No change to environmental baseline*.
Research, Transportation, Shipping, and Tourism	The Proposed Action would positively impact all the proposed action areas through Coast Guard law enforcement (e.g., unlawful activities), national security activities, maritime safety/search and rescue, and a platform for scientific research. The Proposed Action would not result in significant negative impacts or significant harm to research, transportation, shipping, and tourism.		No change to environmental baseline*.
Subsistence Hunting and Cultural Resources	The Proposed Action would positively impact subsistence hunting in the Arctic and Pacific Northwest action areas by providing maritime safety/search and rescue, emergency response, and supporting educational opportunities. The Proposed Action would not result in significant negative impacts or significant harm to subsistence hunting. The Proposed Action would have no significant impact or significant harm on cultural resources in all proposed action areas as cultural resources would be avoided. No subsistence hunting occurs in the Antarctic.		No change to environmental baseline*.

*Once the current fleet of icebreakers operating in the polar regions are decommissioned and no longer in operation; under the No Action alternative, the Coast Guard would eventually be unable to conduct their missions in the polar regions without any icebreakers and therefore, icebreaker operations and training would no longer occur in the polar regions.

**National Snow and Ice Data Center, accessed July 2018: https://nside.org/cryosphere/icelights/2012/04/are-icebreakers-changing-climate

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Acronyms and Abbreviations

° C	degrees Celsius
° F	degrees Fahrenheit
° E	degrees East longitude
° N	degrees North latitude
° S	degrees South latitude
° W	degrees West latitude
ADFG	Alaska Department of Fish and Game
ADCP	Acoustic Doppler Current Profiler
AON	Arctic Observing Network
ARPA	Arctic Research and Policy Act
ATON	Aid to Navigation
AUV	Autonomous Underwater Vehicle
BIA	Biologically Important Area
BMP(s)	Best Management Practice(s)
BOEM	Bureau of Ocean Energy Management
CASS	Comprehensive Acoustic System Simulation
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CGC	Coast Guard Cutter
CGD17INST	Coast Guard District 17 Instruction
CITES	The Convention on International Trade in Endangered Species of Wild Fauna and Flora
cm	centimeter(s)
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CNP	Central North Pacific
Coast Guard	United States Coast Guard
CV	Coefficient of Variation
dB	decibels
μPa	micropascals
dB re 1 μPa	decibels referenced to 1 micropascals
dB re 1 μPa @ 1 m	decibels referenced to 1 micropascals at 1 meter
dBA	A-weighted decibel
DPS	Distinct Population Segment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ENP	Eastern North Pacific
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU(s)	Evolutionarily Significant Unit(s)
FMP(s)	Fisheries Management Plan(s)
FOL(s)	Forward Operating Location(s)
FR	Federal Register

ft	foot (feet)
ft^2	square feet
$gC/m^2/day$	grams of carbon per square meter per day
$gC/m^2/y$	grams of carbon per square meter per year
GRAB	Gaussian Ray Bundle
HAPC	Habitat Areas of Particular Concern
HF	high-frequency marine mammal hearing group
HSPD	Homeland Security Presidential Directive
Hz	hertz
IAATO	International Association of Antarctic Tour Operators
ICEX	Ice Exercises
IMO	International Maritime Organization
in	inch(es)
IUCN	International Union for Conservation of Nature
IWC	International Whaling Commission
kg	kilogram
kHz	kilohertz
km	kilometer(s)
km^2	square kilometers
km/hr	kilometers per hour
lb	pound(s)
LF	low-frequency marine mammal hearing group
m	meter(s)
m^2	square meters
mi	mile(s)
mi^2	square miles
mi/hr	miles per hour
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
MARPOL	International Convention for the Prevention of Pollution from Ships
MBTA	Migratory Bird Treaty Act
MEM	Military Expended Materials
MF	mid-frequency marine mammal hearing group
mg/m^2	milligrams per square meter
mg/m^3	milligrams per cubic meter
MMPA	Marine Mammal Protection Act
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
NAEMO	Navy Acoustic Effects Model
Navy	U.S. Department of the Navy
NEPA	National Environmental Protection Act
nm	nautical mile(s)
NMFS	National Marine Fisheries Service
NMSA	National Marine Sanctuaries Act
NOAA	National Oceanic and Atmospheric Administration
NPFMC	North Pacific Fishery Management Council
NSF	National Science Foundation
NSC	National Security Council
OAML	Oceanographic and Atmospheric Master Library
OCNMS	Olympic Coast National Marine Sanctuary

OPNAV	Naval Operations
NSPD	National Security Presidential Directive
OW	otariid and non-phocid marine carnivore hearing group
PCFG	Pacific Coast Feeding Group
PDD/NSC	Presidential Decision Directive
PEIS	Programmatic Environmental Impact Statement
PFMC	Pacific Fishery Management Council
PIB	polar icebreaker (new)
PTS	Permanent Threshold Shift
PW	phocid marine mammal hearing group
RES	Relative Environmental Suitability
SAR	Search and Rescue
SCAR	Scientific Committee on Antarctic Research
SCICEX	Science Ice Expeditions
SEL	Sound Exposure Level
SOP(s)	Standard Operating Procedure(s)
SOWER	Southern Ocean Whale and Ecosystem Research
SPL	Sound Pressure Level
SRKW	Southern Resident killer whale
TTS	Temporary Threshold Shift
UAV	Unmanned Aerial Vehicle
U.S.	United States
UNEP	United Nations Environment Programme
USAP	United States Antarctic Program
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
WNP	Western North Pacific

CHAPTER 1 INTRODUCTION

1.1 Background

The United States Coast Guard (Coast Guard) is a military, multi-mission, maritime service within the Department of Homeland Security and one of the nation's five armed services. In executing its various missions, the Coast Guard protects the public, the environment, and United States (U.S.) economic and security interests, in any maritime region, including international waters and the Nation's coasts, ports, and inland waterways, as required to support national security.

The United States also has vital national interests in the polar regions. Polar icebreakers enable the United States to maintain defense readiness and all other Coast Guard missions in the Arctic and Antarctic regions. Polar icebreakers enable the Coast Guard to enforce treaties and other laws needed to safeguard both industry and the environment; provide ports, waterways and coastal security; and provide logistical support. This support includes escorting vessels to facilitate the movement of goods and personnel necessary to support scientific research, commerce, national security activities and maritime safety.

In the Arctic, the United States is one of five coastal nations and one of eight nations having territory and citizens in the Arctic. Sovereign rights and responsibilities of the United States include obligations to the citizens of Alaska, economic interests, international responsibilities and treaty obligations, and foreign and domestic policy interests. In the Antarctic, the United States does not claim sovereignty, but seeks to maintain an active and influential presence in accordance with the Antarctic Treaty. For more than 50 years, the United States has contributed its international leadership to preserve Antarctica from political conflict and environmental damage. Coast Guard polar icebreakers are crucial for the United States to maintain these responsibilities in both polar regions.

The Coast Guard's polar icebreaking fleet includes two heavy icebreakers (Coast Guard Cutter [CGC] POLAR STAR and CGC POLAR SEA) and one medium icebreaker (CGC HEALY). CGC POLAR SEA and CGC POLAR STAR were commissioned in 1976 and 1978, respectively. CGC HEALY, the newer and more technologically advanced icebreaker, was added to the fleet in 1999. The Coast Guard's heavy icebreakers have both exceeded their designed 30-year service life. CGC POLAR SEA has remained out of service since 2010 and is not expected to be reactivated and CGC POLAR STAR completed a service life extension in 2013 to allow it to operate for an additional seven to ten years, thus extending its service life to 2023. CGC HEALY will reach the end of its 30-year design service life in 2030.

1.2 Purpose and Need

The U.S. Coast Guard ensures the Nation's maritime safety, security, and stewardship. The Coast Guard's capability and capacity to execute its missions in polar regions allow the U.S. government to advance national interest objectives in the polar regions. However, a lack of infrastructure, polar environmental conditions, and vast distance between operating areas and support bases, all influence the Coast Guard's ability to provide the same level of service and presence in these polar regions that Coast Guard provides in other non-polar areas of operation. Polar icebreakers are required to address the current mission demand and the long-term projected increase in Coast Guard mission demand in polar regions. However, the Coast Guard's current polar icebreaker fleet is nearing the end of its operational service life. The current polar icebreaker fleet consists of two heavy and one medium icebreaker; however, the

Coast Guard has determined that due to the projected increase in demand in the polar regions, Coast Guard needs to replace the two heavy polar icebreakers (the status quo) with three heavy icebreakers, so the Coast Guard could meet future mission demand. Thus, the Coast Guard proposes the design, build, and operation of up to six polar icebreakers (PIBs) to provide consistent and reliable presence in the polar regions. The Proposed Action would allow the Coast Guard to recapitalize its polar icebreaker fleet to ensure continued access to both polar regions and support the country's increasing economic, commercial, maritime and national security needs.

Polar regions are becoming more important to national and international interests. In the Arctic, diminishing sea ice has created navigation routes through the Northwest Passage and an opening of ice in the Northern Sea Route (Figure 1-1). In general, vessel activity in the Arctic has increased with the retreat of sea ice (U.S. Coast Guard 2016). Expanding commercial ventures have increased maritime traffic in the Bering Strait by 145 percent between 2008 and 2015 (U.S. Coast Guard 2016). The maritime traffic includes a range of vessels, including commercial icebreakers, cruise ships, oil and gas industry vessels, government and private research vessels, ore carriers, coastal resupply vessels, recreational vessels, and commercial fishing boats. A polar icebreaker would also provide year-round access to polar regions and would provide a platform of opportunity from which to measure, observe, describe, and understand ecosystem structure and function, physical and biogeochemical linkages, and impact of physical drivers to adequately understand ongoing changes in the polar ecosystems. In support of the Coast Guard’s science mission, an icebreaker would provide this unique platform of opportunity for scientists to conduct research in the polar regions. Coast Guard would be authorized under the researcher’s scientific research permit or authorization, as applicable.

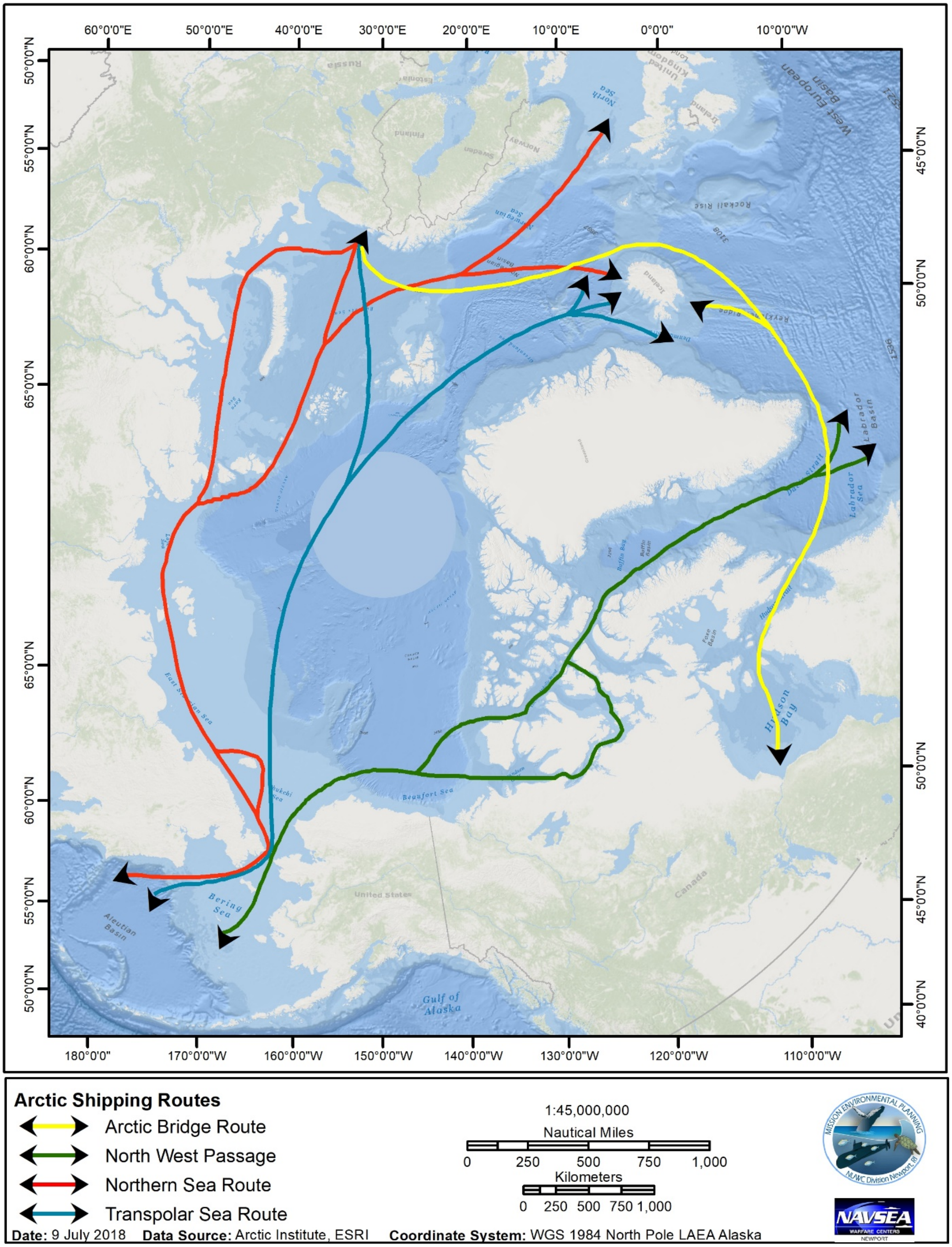

Figure 1-1. Opening Arctic Shipping Routes as a Result of Decreasing Summer Sea Ice

In the Antarctic, one of the Coast Guard's priorities is assisting with resupplying McMurdo Station with food and fuel and providing support to related Antarctica logistics. However, changing ice conditions in Antarctic waters have made the McMurdo resupply mission more challenging since 2000 (See National Research Council, Polar Icebreakers in a Changing World, An Assessment of U.S. Needs, Washington, 2007, pp. 6-7, 14, 63). In addition, the number of tourists visiting Antarctica has steadily increased in recent years. Coast Guard icebreaking capabilities, particularly heavy polar icebreakers, are necessary to provide support in Antarctica.

Any increase in vessel traffic in the polar regions increases the potential for more search and rescue missions, water pollution, illegal fishing, and infringement on the U.S. Exclusive Economic Zone (EEZ), which requires Coast Guard presence. There is a long term increase in Coast Guard mission demand projected, which would therefore require additional support from icebreakers. The Proposed Action would allow the Coast Guard to meet the increasing demand in the polar regions, as well as year-round mission requirements (see Section 2.1).

1.3 PROPOSED ACTION

The Coast Guard proposes the design and build of up to six polar icebreakers, with planned service design lives of 30 years each. This would provide consistent and reliable Coast Guard presence in the Arctic and Antarctic to fulfill the Coast Guard's missions, guided by the Coast Guard's Arctic Strategy and Arctic Strategy Implementation Plan (with direction from the President of the United States), the National Security Strategy, National Military and Maritime Strategies, National Strategy for the Arctic Region, Arctic Region Policy National Security Presidential Directive (NSPD) 66/Homeland Security Presidential Directive (HSPD) 25, National Strategies for Homeland Security, and Maritime Domain Awareness, National Ocean Policy, and Executive Order (EO) 13580. The current polar icebreaker program acquisition strategy is to construct up to three heavy icebreakers and up to three medium icebreakers, with planned service design lives of 30 years each. The first of these new PIBs is expected to be delivered in 2023. The Coast Guard proposes to conduct polar icebreaker operations and training exercises to meet Coast Guard mission responsibilities in the U.S. Arctic and Antarctic regions of operation, in addition to vessel performance testing post-dry dock in the Pacific Northwest near the current polar icebreaker homeport of Seattle, Washington[2]. Further information on the Proposed Action is provided in Chapter 2.

1.4 REGULATORY SETTING

The eleven Coast Guard missions are port, waterways, and coastal security; drug interdiction; aids to navigation; search and rescue; living marine resources; marine safety; defense readiness; migrant interdiction; marine environmental protection; ice operations; and other law enforcement (e.g., illegal fishing). In both polar regions the Coast Guard's objectives are to ensure the safety, security, and enforcement of those laws under Coast Guard's purview, and provide support to the maritime community. Legislation and executive orders assign the Coast Guard a wide range of responsibilities applicable to polar regions. The NSPD 66/HSPD 25 articulates U.S. interests and policy, identifies associated actions that the United States will take to further those policies, and tasks the Secretaries of State, Defense, and Homeland Security to develop greater capabilities and capacity to project a sovereign maritime presence. The National Strategy for the Arctic Region prioritizes actions and

[2] The exact location for homeporting has not been determined, but the current fleet of polar icebreakers is homeported in Seattle, Washington.

positions of the United States to respond effectively to the changing conditions in the Arctic. The Coast Guard's objectives are to meet national and homeland security needs, to collaborate with indigenous communities, and to enhance scientific monitoring and research. National policy objectives for Antarctica are articulated in Presidential Decision Directive/National Security Council Report (PDD/NSC)-26. It states that the United States has important foreign policy and national security interests and was reaffirmed as the current source or Presidential Antarctic policy by HSPD-25. Icebreakers would enable the Coast Guard to meet these directives and responsibilities.

The Coast Guard is the primary service for the United States that provides icebreaking capacity and commissioned the 2010 High Latitude Mission Analysis Report and 2013 Polar Icebreaker Mission Need Statement to identify icebreaking capability gaps in both the Arctic and Antarctic regions. The June 2013 Polar Icebreaker Mission Need Statement[3] established the need for polar icebreaker capabilities provided by the Coast Guard, to ensure that it can meet current and future mission requirements in the polar regions. Several policy documents, including Coast Guard and Navy directives, international agreements, and National Security directives, provide high-level guidance for polar icebreaker operations and support. In August 2016, the Coast Guard established an integrated program office with the U.S. Department of the Navy (Navy) to leverage the Navy's shipbuilding expertise for acquiring icebreakers. This arrangement was formalized through a series of Memorandums of Understanding and Agreement in 2017. Additionally, the Fiscal Year 2018 National Defense Authorization Act authorized procurement of one Coast Guard heavy polar icebreaker vessel, as well as established additional parameters for how the integrated program office would contract for polar icebreakers (U.S. Government Accountability Office 2018).

1.4.1 Scope of the Programmatic Environmental Impact Statement

The Coast Guard has prepared this Programmatic Environmental Impact Statement (PEIS) in accordance with the National Environmental Policy Act (NEPA), as implemented by the Council on Environmental Quality (CEQ) Regulations (40 Code of Federal Regulations [CFR] §§ 1500 *et seq.*); Department of Homeland Security Directive Number 023-01; and Coast Guard Commandant Instruction M16475.1D. The Coast Guard will issue a Record of Decision once the Final PEIS has been made publicly available for 30 days.

The purposes for preparing this PEIS are to:

- identify and assess the potential impacts on the natural and human environment that would result from the implementation of the Proposed Action
- describe and evaluate reasonable alternatives to the Proposed Action
- identify and recommend specific mitigation measures, as necessary, to avoid or minimize environmental effects
- encourage and facilitate involvement by the public and interested agencies in the environmental review process

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[3] Department of Homeland Security, *Polar Icebreaking Recapitalization Project Mission Need Statement, Version 1.0*, approved by DHS June 28, 2013, pp. 1, 9. Report on polar icebreaker modernization, -although polar ice is diminishing due to climate change, observers generally expect that this development will not eliminate the need for U.S. polar icebreakers, and in some respects might increase mission demands for them. Even with the diminishment of polar ice, there would still be significant ice-covered areas in the Polar Regions.

The topics addressed in this PEIS include oceanic waters; wildlife and aquatic resources; special status species; recreation and special interest areas; socioeconomics; subsistence hunting; noise (in air and underwater); and cumulative impacts. This PEIS describes the affected environment as it currently exists based on available information, the environmental consequences of incorporation of three new heavy and three medium PIBs into the Coast Guard's fleet and associated operations and training in the U.S. Arctic and Antarctic and vessel functionality testing post dry-dock in the waters off the U.S. Pacific Northwest. It also compares the project's potential impact to that of various alternatives.

Polar icebreaker operations and training would be expected after delivery of the first PIB. Because the first new Coast Guard PIB is not expected to be operational until 2023, the Coast Guard anticipates that supplemental NEPA documentation would be prepared in support of individual proposed actions. New information would be tiered[4] to this PEIS and may include, but is not limited to, changes to a species listing status or any other applicable laws and directives. Additionally, more detailed NEPA analyses would likely be required for vessel homeporting, maintenance, and decommissioning. At this stage, plans for these actions have not been made and therefore cannot yet be analyzed for potential impacts. Therefore, the sequence and future planning for this Proposed Action would have a more specific NEPA analysis as more information becomes available. Because there are no anticipated significant changes, this PEIS analyzes expected vessel operation and training activities based on the current Coast Guard fleet's operations and training activities.

1.4.1.1 Agency Coordination Process

The Coast Guard has been working with the Navy under its Integrated Program Office and polar icebreaker program. The Integrated Program Office is using a full and open competition strategy for detail design and construction; a single contract award would be made in fiscal year 2019.

According to the January 30, 2002, CEQ guidance to the heads of Federal agencies on implementing the procedural requirements of NEPA, lead agencies preparing a PEIS are required to determine if other Federal agencies are interested and appear to be capable of assuming the responsibilities of becoming a cooperating agency under 40 CFR § 1501.6. "Cooperating agency" as defined under this title includes any other Federal agency that has jurisdiction by law or that has special expertise with respect to any environmental issue that should be addressed in the PEIS.

The 2002 guidance states: "The benefits of enhanced cooperating agency participation in the preparation of NEPA analyses include: disclosing relevant information early in the analytical process; applying available technical expertise and staff support; avoiding duplication with other Federal, State, Tribal and local procedures; and establishing a mechanism for addressing intergovernmental issues. Other benefits of enhanced cooperating agency participation include fostering intra- and intergovernmental trust (e.g., partnerships at the community level) and a common understanding and appreciation for various governmental roles in the NEPA process, as well as enhancing agencies' ability to adopt environmental documents. It is incumbent on Federal agency officials to identify as early as practicable in the environmental planning process those Federal, State, Tribal and local government agencies that have jurisdiction by law and special expertise with respect to all reasonable alternatives or

[4] Tiering refers to the coverage of general matters in broader NEPA documentation (e.g., Environmental Impact Statement) with subsequent narrower-focused NEPA documents that incorporate by reference the general discussions from the boarder NEPA document. This more focused NEPA document concentrates on the project-specific action(s) and appropriate specific issues (40 CFR 1508.28; see also 40 CFR 1500.4(i), 1502.4(d), 1502.20).

significant environmental, social or economic impacts associated with a proposed action that requires NEPA analysis."

The Coast Guard is the lead Federal agency for preparing this PEIS. There are no cooperating Federal agencies under NEPA.

1.5 Public Outreach, Review and Comment

In addition to soliciting Cooperating Agency input, the Coast Guard initiated and/or accepted written correspondence from the following interested agencies and organizations:

- Environmental Protection Agency (EPA)
- North Slope Borough
- Bureau of Land Management

Additional information on the content of the correspondence can be found in Chapter 7, Consultation and Coordination Process and in Appendix C: Response to Public Comments.

Placeholder: *This section is incomplete because the Coast Guard intends to conduct a 45-day public comment period on the Draft PEIS and will update this section before the Final PEIS is completed.*

1.5.1 Communication Method

Communication methods used by the Coast Guard to distribute the proposed project information to residents of Alaska included: radio, newspapers, fliers, electronic mail, and Web sites. Public presentations of the project proposal, and research and assessment findings provided at public meetings, were advertised with fliers, newspaper postings, and radio announcements.

A project website was established to facilitate public input within and outside the Arctic, Antarctic and Pacific Northwest regions (http://www.dcms.uscg.mil/Our-Organization/Assistant-Commandant-for-Acquisitions-CG-9/Programs/Surface-Programs/Polar-Icebreaker/). The scheduling of public meetings was publicized in press releases available on the Coast Guard's website and in the Federal Register Notice (83 Federal Register [FR] 18319; 26 April 2018). Public meetings were held in Nome (May 7, 2018), Kotzebue (May 9, 2018), Anchorage (May 11, 2018), and in Barrow/Utqiagvik (referred to as Barrow/Utqiagvik in this PEIS; May 14, 2018). A Notice of Availability and request for comments [INSERT DATE] was publicized in the Federal Register Notice [INSERT DATE] to notify the public of the 45-day public review period for the Draft PEIS.

1.6 ORGANIZATION OF THE PEIS

This PEIS is organized as follows:

- Chapter 1 provides background information, identifies the purpose and need for the Proposed Action, and regulatory setting, including any applicable laws and directives.
- Chapter 2 describes alternatives, including the preferred alternative and the Proposed Action.
- Chapter 3 describes the existing environment and provides background information on the physical, biological, and socioeconomic environments and the best available science on potentially affected biological resources in the proposed action areas.
- Chapter 4 describes the environmental consequences of the Proposed Action, including acoustic and physical stressors, and socioeconomic benefits.
- Chapter 5 identifies cumulative impacts and describes past, present, and reasonably foreseeable future actions.
- Chapter 6 discusses Coast Guard protective measures.
- Chapter 7 describes consultation and coordination.
- Chapter 8 presents the conclusion
- Chapter 9 presents compliance with applicable laws, directives, Executive Orders, and treaty rights
- Chapter 10 presents a list of prepares of the document.
- Chapter 11 provides references.
- Appendix A identifies those species whose range overlaps with potential transiting areas and potential impacts described in Chapter 4.
- Appendix B provides the quantifying acoustic impacts analysis on marine mammals, including the method and analytical approach.
- Appendix C describes Agency Coordination including responses to public comments.
- Appendix D describes changes made from the Draft PEIS to the Final PEIS.

CHAPTER 2 PROPOSED ACTION AND ALTERNATIVES

2.1 ALTERNATIVE 1, PREFERRED ALTERNATIVE: PROPOSED ACTION

The Proposed Action supports the Coast Guard's design and build of up to six polar icebreakers to fulfill mission requirements in the Arctic and Antarctic. The current PIB acquisition strategy is to construct up to three heavy icebreakers and may potentially expand to include up to three medium icebreakers, with planned service design lives of 30 years each. The first of these new PIBs, a heavy icebreaker, is expected to be delivered in 2023. The Coast Guard proposes to conduct polar icebreaker operations and training to meet Coast Guard mission responsibilities in the Arctic and Antarctic, in addition to vessel performance testing post-dry dock in the Pacific Northwest, near the current homeport of Seattle, Washington[5]. PIBs would be transcontinental vessels that would travel worldwide to support the Coast Guard's missions in the Antarctic and Arctic proposed action areas. Appendix A lists possible transit routes that the PIB could use when transiting between the proposed action areas, and includes ports that may be used by the PIB to support the Coast Guard's mission. An example transit route for an Antarctic mission could begin in Seattle, Washington; transit to Honolulu, Hawaii; to Hobart, Australia; to McMurdo Station, Antarctica; to Fiji; and return to Seattle, Washington. Specific information on transit routes are unavailable, at this time; therefore, this PEIS analyzes broadly defined transit routes.

While Coast Guard must work toward environmental compliance prior to the design and build of the icebreaking vessel, the vessel is not expected to impact the environment or biological resources until is built, deployed, commissioned, and operational. Vessel construction is not expected to impact any physical or biological resources. Polar icebreaker operations and training would be expected after delivery of the first PIB. Because the first new Coast Guard PIB is not expected to be operational until 2023, the Coast Guard anticipates that supplemental NEPA documentation would be prepared in support of individual proposed actions. New information would be tiered[6] to this PEIS and may include, but is not limited to, changes to a species listing status or any other applicable laws and directives. Additionally, more detailed NEPA analysis would be required for vessel homeporting, maintenance, and decommissioning. At this stage, plans for these actions have not been made and therefore cannot yet be analyzed for potential impacts. Therefore, the sequence and future planning for this Proposed Action would have a more specific NEPA analysis as more information becomes available. Because there are no anticipated significant changes to Coast Guard missions in the polar regions, this PEIS analyzes expected vessel operation and training activities based on the current Coast Guard fleet's operations and training activities.

Similar to the current fleet's operations, the Proposed Action would provide land/shore, air, and sea operations; training exercises; and, tribal and local government engagement to meet the Coast Guard's mission responsibilities in the polar regions. To serve the public, the Coast Guard has organized responsibilities into six fundamental roles: (1) maritime safety/search and rescue; (2) national defense; (3) maritime security; (4) maritime mobility; (5) protection of natural resources; and (6) ice operations, where icebreakers play a key role.

[5] The exact location for homeporting has not been determined, but the current fleet of polar icebreakers is homeported in Seattle, Washington.

The new PIBs along with other associated Coast Guard assets, would perform these six fundamental roles and same humanitarian, law enforcement and national security duties, functions, and missions of the Coast Guard as are performed in other geographic areas of responsibility. These include:

5. searching for either passengers and crew that fall overboard from recreational, commercial, or government vessels in Arctic or Antarctic waters, or victims of crashed aircraft in the water
6. rescuing either passengers and crew that fall overboard from recreational, commercial, or government vessels in Arctic or Antarctic waters, or victims of crashed aircraft in the water
7. rescuing persons on vessels in Arctic or Antarctic waters in medical scenarios requiring evacuation by Coast Guard helicopter or Coast Guard rescue vessel, sometimes requiring a Coast Guard rescue swimmer to enter the water himself or herself to place the person in a harness or rescue basket to be winched into a hovering helicopter
8. freeing a beset vessel which may require towing or escort to safety
9. breaking ice to allow safe passage to vessels or to free beset vessels
10. establishing aids-to-navigation in Arctic waters
11. enforcing Federal law in the U.S. Territorial Sea and the High Seas of Arctic waters
12. maintaining awareness of vessel and aircraft activities in the Arctic maritime domain
13. broadening Coast Guard partnerships with Alaska Native Villages in the Arctic
14. enhancing and improving preparedness, prevention, and response capabilities
15. oil spill response, mapping, and science

Some of the activities listed above are integral to Coast Guard emergency response. Although emergency response is not a part of the Proposed Action, training is required. Therefore, training on a PIB for an emergency response is considered part of the Proposed Action.

One or more PIBs, as well as multiple support vessels, aircraft, and personnel deployed throughout the Antarctic and Arctic Regions would conduct PIB activities. Those activities pursue four main objectives:

1. perform Coast Guard missions and activities in the polar regions
2. advance Arctic maritime domain awareness
3. broaden partnerships
4. enhance and improve preparedness, prevention, and response capabilities

Table 2-1 provides a summary of activities associated with the Proposed Action and the proposed action area(s) where these activities are expected to occur. Table 2-2 provides a summary of the proposed action activities and the expected frequency of occurrence. None of the activities below are expected to occur during transit. Sections 2.1.1 through 2.1.5 below provide further details for each activity.

Table 2-1. Summary of Proposed Action Activities and Applicable Proposed Action Area(s)

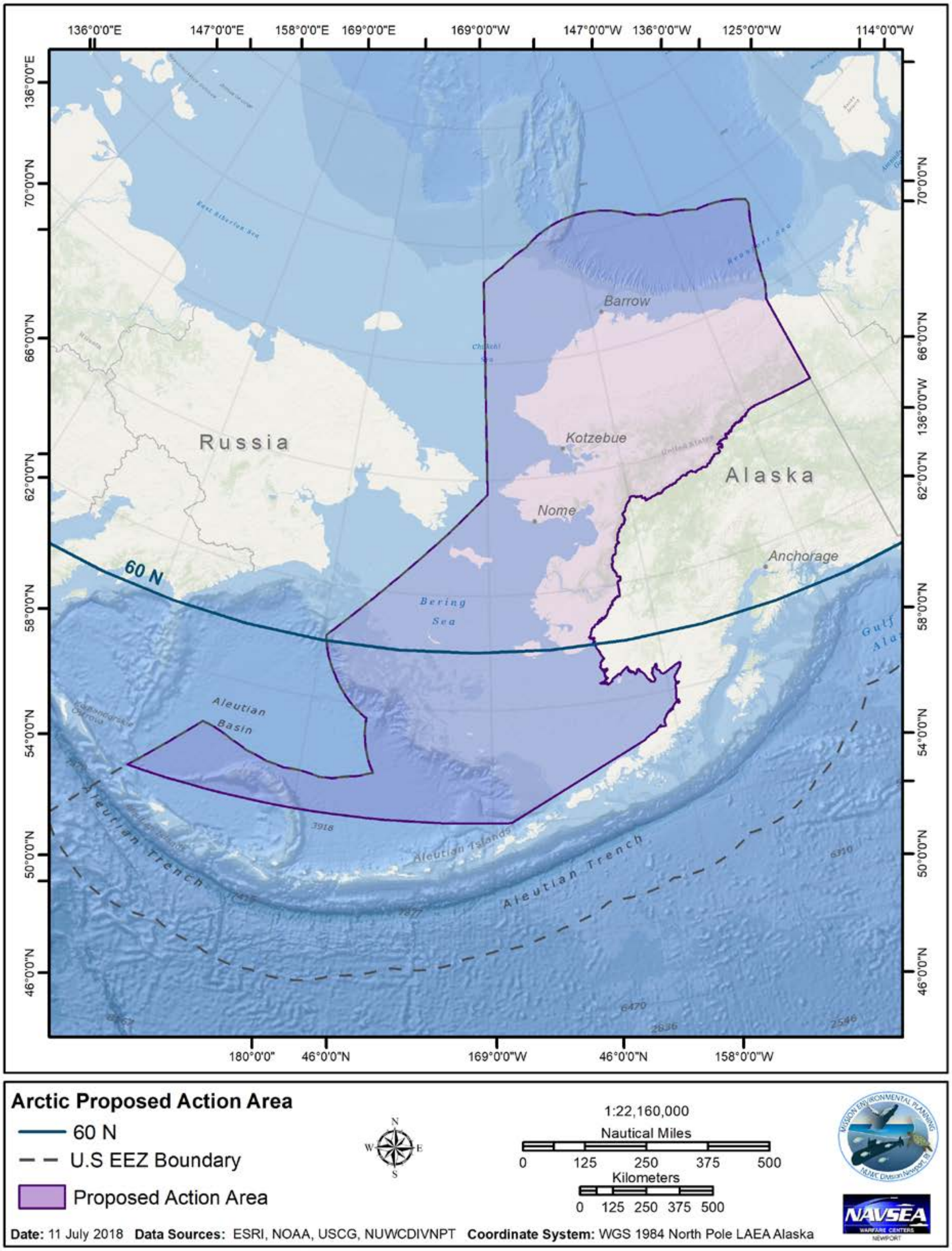
Activity[1]	Proposed Action Area		
	Arctic	Antarctic	Pacific Northwest
Vessel Operations			
Icebreaking	x	x	
Maneuverability-Propulsion Testing			x
Maneuverability-Ice and Bollard Condition Testing	x		
Vessel Escort[2]	x	x	
Vessel Tow[2]	*	x	
Passenger Transfer	x	x	
Law Enforcement	x		
Search and Rescue Training[2]	x	x	
Scientific Support Missions[3]	x	x	
AUV Deployments	x		
Diver Training	x	x	x
Fueling Underway	x	x	
Gunnery Training	**		x[4]
Marine Environmental Response Training	x		x
Aircraft Operations			
Landing Qualifications	x	x	
Reconnaissance	x	x	
Vertical Replenishments and Mission Support	x	x	
Community Outreach and Passenger Transfer	x	x	

AUV: Autonomous Underwater Vehicle
[1]Patrols would encompass all activities listed in table.
[2] Excluding the emergency response associated with these Proposed Action activities.
[3] Coast Guard personnel may participate in scientific surveys as part of the Coast Guard mission, but those activities would be covered under the researcher's permit or authorization.
[4] Pacific Northwest, gunnery training would occur in the open ocean or on established U.S. Navy Ranges.
*Vessel towing in the Arctic is possible, but considered rare.
**Gunnery training could occur in the Bering Sea, but is considered rare due to weather limitations.

2.1.1 Proposed Action Areas

2.1.1.1 Arctic Proposed Action Area

In order to accurately capture all areas that may be impacted, both directly and indirectly, as required by 50 CFR § 402.02, the Coast Guard has determined that the proposed action area for the "Arctic" as defined by the United States Arctic Research and Policy Act (ARPA) of 1984 Public Law 98-373 § 112, with the following modification: the southern boundary of the proposed action area runs from the point of intersection of the Maritime Boundary Line and the line of 54 degrees North (°N) latitude, and follows the line of 54° N latitude eastward to a point of intersection at longitude 168 degrees West (°W) and latitude 54° N, thence follows a rhumbline in an east, northeast direction to a point of intersection at longitude 160° W and the ARPA boundary line, which is near Cape Seniavin on the Alaska Peninsula (Figure 2-1). Sea/Surface operations in support of the Proposed Action, including other Coast Guard assets (e.g., smaller vessels) would likely only occur north of 60° N within the U.S. EEZ due to the proximity of the icebreaker to those ports where these other Coast Guard assets are berthed. Air operations in support of the Proposed Action would primarily occur within 180 nautical miles (nm) of the primary Forward Operating Location (FOL), Kotzebue, with some flights also occurring within 180 nm of alternate FOL locations of Barrow/Utqiagvik, Deadhorse/Prudhoe Bay and Nome, as shown in Figure 2-2, as well as with some flights being conducted to support icebreaker operations occurring within 60 nm of the flight-deck-capable icebreaker supporting the Proposed Action. FOLs are temporary, but in already established bases for Coast Guard sea and air support in the Arctic.



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2 **Figure 2-1. Arctic Proposed Action Area**

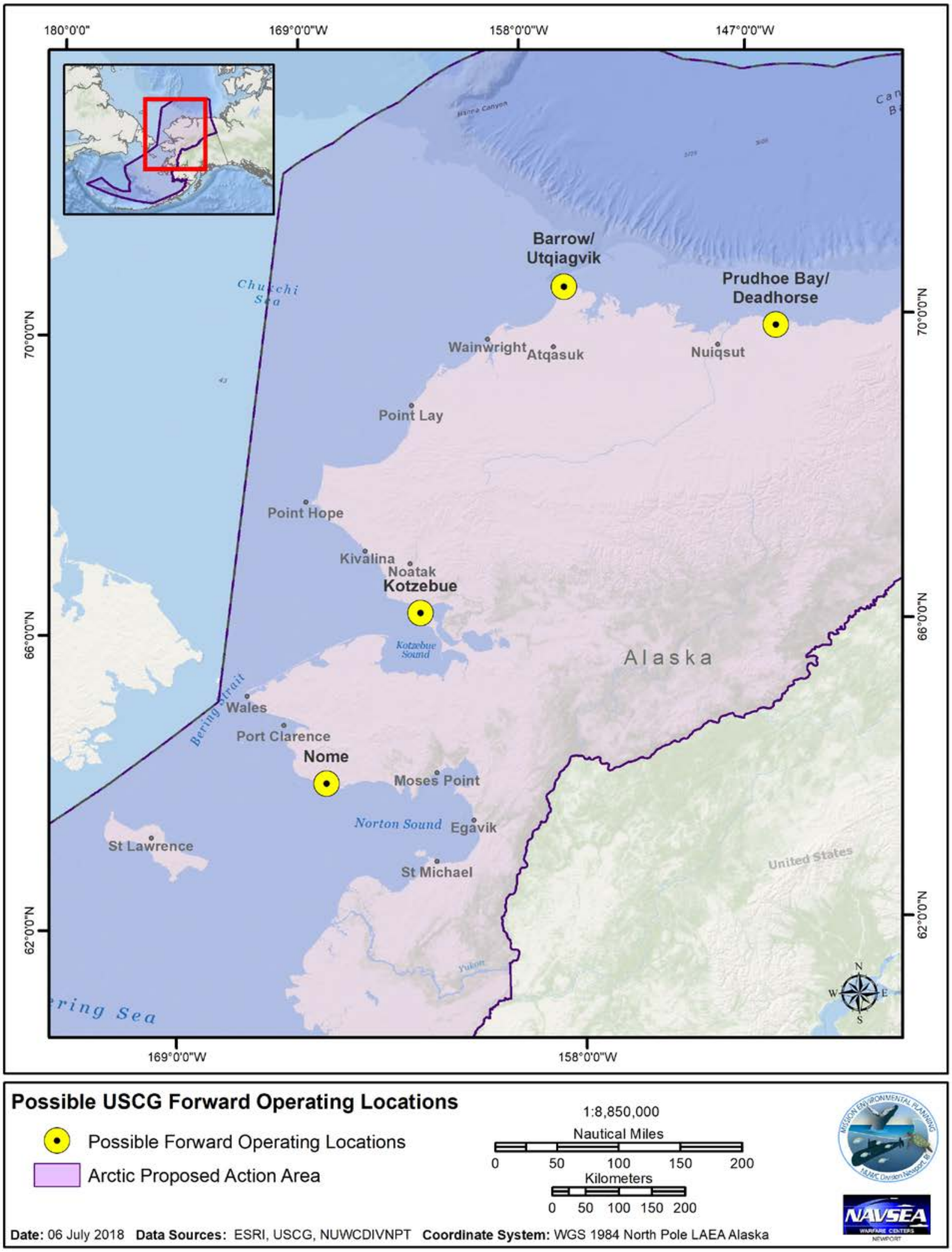


Figure 2-2. Possible Coast Guard Temporary Forward Operating Locations

2.1.1.2 Antarctic Proposed Action Area

The Antarctic is defined as all land and waters south of 60 degrees South (°S) latitude. The Antarctic proposed action area is located in the Ross Sea adjacent to McMurdo Station. The Ross Sea is a 1.9 million square mile (mi^2; 3.6 million square kilometer [km^2]) stretch of ocean off the coast of Antarctica (Figure 2-3) and almost completely within the Ross Sea Marine Protected Area. Additional details on the Ross Sea Marine Protected Area can be found in Section 3.3.1.2. There is no permanent population on the Antarctic continent, save for approximately 4,400 researchers that reside there during the summer and 1,100 researchers during the winter (Central Intelligence Agency 2017). With no permanent human population and virtually uninhabitable conditions, the activity of humans at sea is also limited. McMurdo Station, located at the edge of the Ross Sea, is the port of entry for most United States Antarctic Program (USAP) cargo and personnel on the continent, and serves as a logistics facility for airborne re-supply of inland stations and for field science projects. It is also the waste management center for much of the USAP.

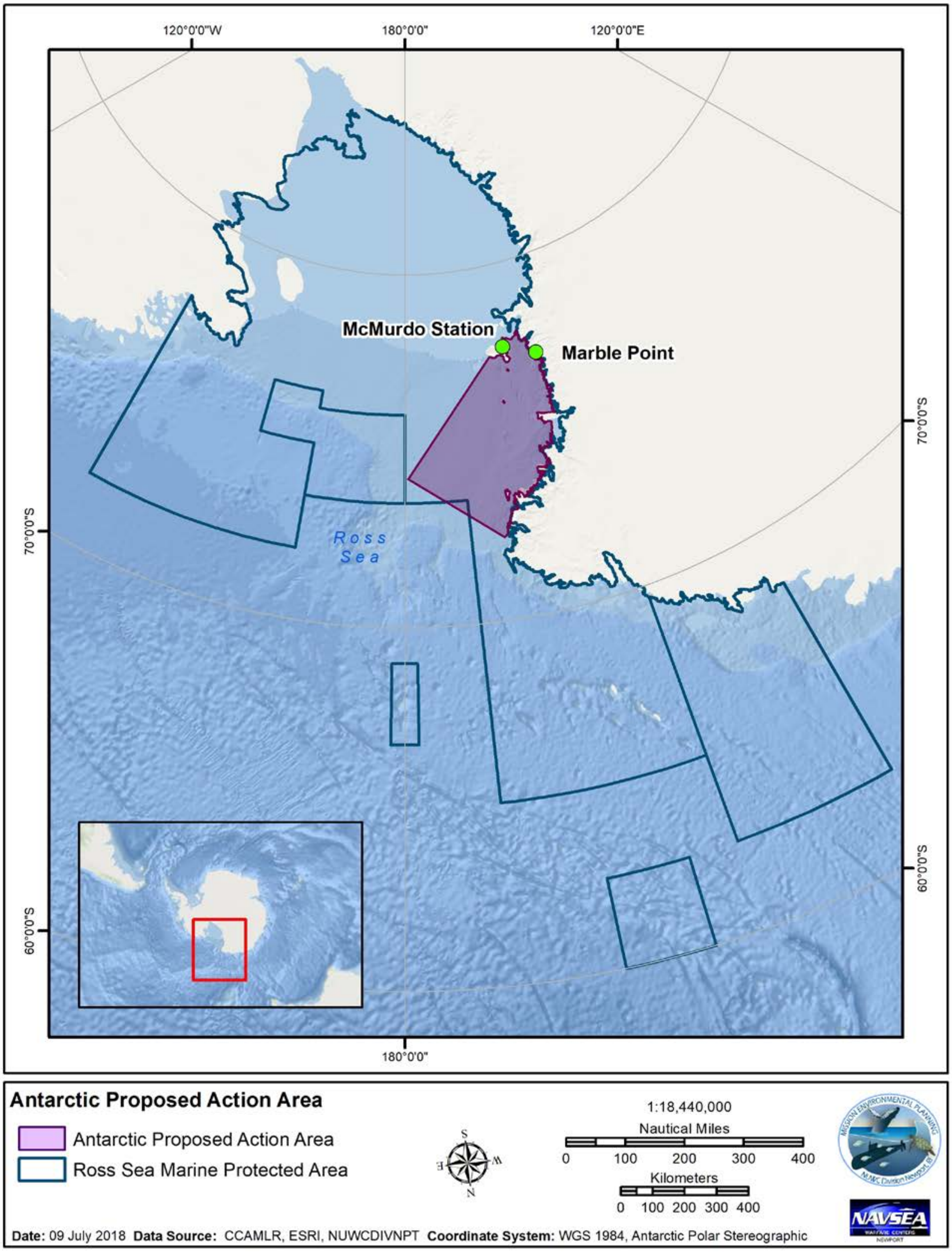


Figure 2-3. Antarctic Proposed Action Area

2.1.1.3 Pacific Northwest Proposed Action Area

The Pacific Northwest proposed action area is off the coast of Washington State, offshore of Vancouver Island, British Columbia, Canada and the Strait of Juan de Fuca, seaward of the Olympic Coast National Marine Sanctuary (Figure 2-4). The Olympic National Marine Sanctuary includes most of the continental shelf and several major submarine canyons in the area. This sanctuary includes 3,188 mi^2 (8,257 km^2) of waters off the coast of Washington, extending 22 to 43 nm from the coast.

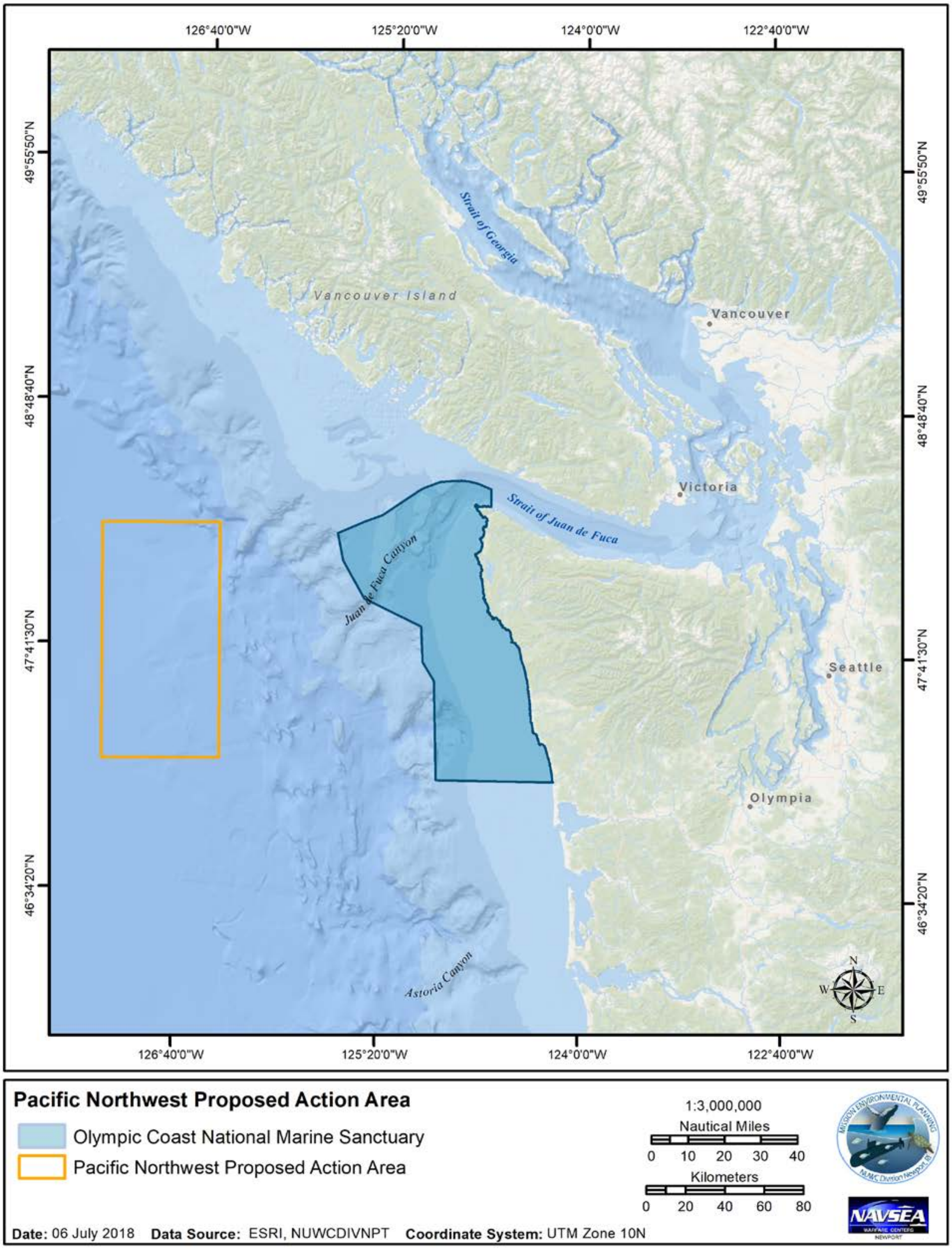


Figure 2-4. Pacific Northwest Proposed Action Area

2.1.2 Patrols

PIBs would go on patrol to provide Coast Guard presence in the Arctic and Antarctic proposed action areas (Figure 2-1 and Figure 2-3, respectively). Patrol schedules and deployments would vary depending on how many PIBs are actually active in the fleet. An average PIB patrol is 80 days, including time the PIB spends icebreaking, loitering, and transiting. For context, we provide example scenarios of deployments for each of the polar regions using a total of three PIBs below to illustrate the minimum number of icebreakers necessary for the Proposed Action. Note that this PEIS analyzes potential impacts from a total of six new icebreakers: three heavy and three medium, as that is the expected maximum to provide Coast Guard presence. Patrols would not occur in the Pacific Northwest proposed action area.

2.1.2.1 Arctic Proposed Action Area

Using an example scenario of three PIBs serving the Arctic, two PIBs could alternate deployment in the Arctic proposed action area, while the third would be in dry dock for maintenance. Each PIB deployed to the Arctic proposed action area would perform two, 3-month patrols per calendar year (up to a total of 6 months of deployment per PIB, totaling 12 months of PIB coverage). Thus, under the assumption of two PIBs alternating patrol deployment through the year, the Coast Guard could maintain PIB presence on patrol in the Arctic proposed action area year-round while upholding the vessel maintenance schedule without a gap in service, because the third PIB would be in dry dock. It is expected that each year there would be one Arctic icebreaking patrol in the Arctic proposed action area (Figure 2-1). If a total of six polar icebreakers are commissioned, the scenario would likely be modified from what was described above for three PIBs; however, during normal operations and training, the Coast Guard would not anticipate more than two patrolling PIBs in any one proposed action area at any time due to maintenance schedules and rotation.

2.1.2.2 Antarctic Proposed Action Area

In the Antarctic proposed action area, the Coast Guard would perform seasonal patrols. In the example scenario of a Coast Guard fleet of at least three PIBs (as described above) and to maintain a seasonal presence in the Antarctic proposed action area, one of the three PIBs could be deployed to the Antarctic proposed action area instead of to the Arctic proposed action area (e.g., one deployed in the Arctic proposed action area and one in dry-dock). A PIB in the Antarctic proposed action area could be on patrol twice annually for 4.5 months at a time, including transit to, in, or from the Antarctic proposed action area. It is expected that each year there would be at least one, but up to two, PIB patrols in the Antarctic proposed action area (Figure 2-3).

2.1.3 Vessel Operations

Vessel operations for a PIB include icebreaking, functionality and maneuverability testing, propulsion testing, ice condition testing, and bollard testing in ice, escorting vessels, towing vessels, passenger transfer (e.g., small boat), law enforcement, search and rescue, autonomous underwater vehicle (AUV) deployments, missions supporting scientific research, diver training, fueling underway, defensive and offensive gunnery training, and marine environmental response training. Each of these operations and training events are described below, as well as in further detail in Table 2-1 and in Chapter 4.

2.1.3.1 Icebreaking

An icebreaker is a special type of vessel designed to navigate through ice-covered waters and provide safe passage for other boats and ships. One of the largest cutters operated by the Coast Guard is an icebreaker. These cutters, specifically designed for icebreaking, have reinforced hulls, special icebreaking bows, and strengthened machinery systems.

Icebreaking would only occur in the Arctic and Antarctic proposed action areas and only in ice-covered areas and only when icebreaking is needed. The amount of time a new PIB would spend icebreaking would vary, based on the need and ice cover. Icebreaking could last up to a maximum of 16 hours each day, but the actual amount of time the PIB would be icebreaking in a 24-hour period is expected to be less than the maximum number of hours. During icebreaking operations, vessel speed would range from 3 to 6 knots, and may be even slower when breaking heavy ice. Engine power and the amount of time the engine running at that power could also vary depending on the type of icebreaking required in the Arctic and Antarctic proposed action areas, as summarized in Table 2-2. Since PIBs have not been constructed yet, the best available information on their acoustic "signatures" (i.e., the distribution and intensities of different sound frequencies emitted) included Roth et al.'s (2013) study of CGC HEALY conducted in the central Arctic Ocean. Icebreaking, for example, can occur under full power, half power, or quarter power. Because sound signatures were not correlated to the icebreaker's power when icebreaking, the Roth et al. (2013) study provided sound signatures of the icebreaker in 8/10 ice coverage and 3/10 ice coverage, which were used in the modeling conducted (see Section 4.1.4 and Appendix B) to represent full power and quarter power ice breaking, respectively. The sound signature of the 5/10 icebreaking activities, which would correspond to half-power icebreaking, was not reported in (Roth et al. 2013); therefore, the full-power signature was used as a conservative proxy for the half-power signature. The general method for icebreaking would be to drive the ship up on top of the ice until the weight of the ship breaks the ice (Figure 2-5). The sloped bow of CGC HEALY, for example, enables it to ride up on top of the ice while the stern sinks lower in the water. The force of buoyancy acting on the submerged portion of CGC HEALY's stern creates a lever-like action bringing the weight down onto the ice and breaking it. In addition, icebreakers often need to scarf the edge of the channel that was created with the initial break-in to widen it. It is expected that any new icebreakers would utilize this same type of method to break ice. Based on historical data, icebreaking may also be required while the PIB is towing a vessel in distress (see Section 2.1.3.3).

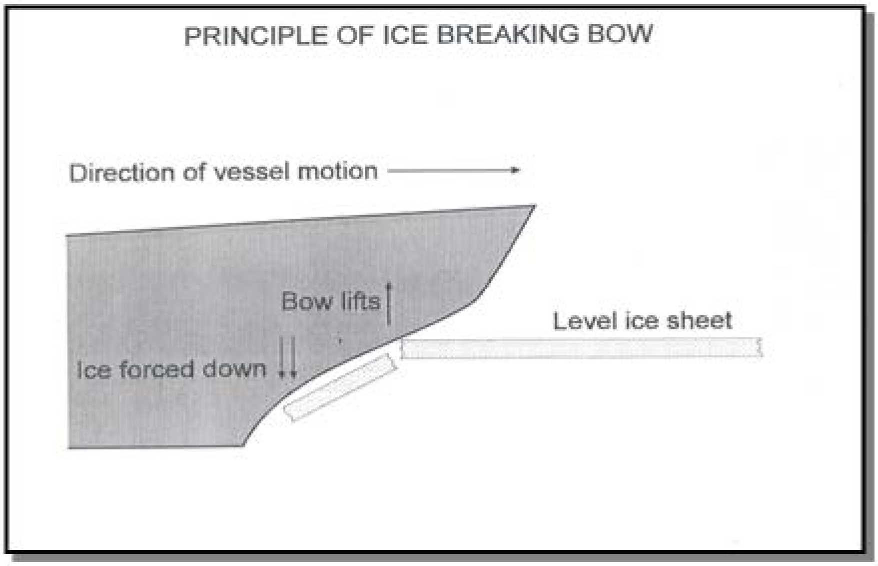


Figure 2-5. The General Method for Icebreaking by an Icebreaker Expected for a New PIB

Icebreaking in the Arctic would occur throughout the Arctic proposed action area, but most often during the spring through fall months, though the exact timing would be dictated by the ice extent and may be required year-round as ice conditions change. During an Arctic patrol (see Section 2.1.2.1) there would be an average of 21 days of icebreaking.

Antarctic icebreaking would support the break-in of McMurdo Station and Marble Point, with both occurring in the austral summer. During an Antarctic patrol (see Section 2.1.2.2) there would be an average of 26 days of icebreaking.

2.1.3.2 Functionality and Maneuverability Testing

Functionality and maneuverability testing for a new PIB would be similar to the testing conducted for the current fleet of Coast Guard icebreakers consisting of propulsion testing, ice condition testing, and bollard testing in ice. All are described in detail below.

2.1.3.2.a Propulsion Testing

The exact location of the homeport for a new PIB is not known at this time. This analysis considered the current polar icebreaker homeport as Seattle, Washington because the current fleet of polar icebreakers use Seattle as a homeport. Propulsion testing consists of two-day sea trials and occurs after dry dock and post-delivery testing. Post-delivery maneuverability testing would also occur in the Pacific Northwest proposed action area and would be conducted to validate the control and maneuverability of the PIB after dry dock. Testing would run for up to two hours (at a time) with the vessel moving at full power, over one or two days. Propulsion testing for the PIB would occur in ice-free waters in the Pacific Northwest proposed action area. Testing would consist of the PIB running at speeds between 12-17 knots and executing various maneuvers (i.e., straight lined or tight turned maneuvers). Additionally, a turning circle or radius test would also be conducted to find out how much area is needed to turn the ship. Active acoustic sources that would be expected include the depth sounder and Doppler Speed Log (used for ship safety) (see Section 2.1.5).

2.1.3.2.b Ice Condition Testing

Ice condition testing would occur once per decade in the Arctic proposed action area. Ice condition testing for the PIB would consist of a training test for a channel departure and a star maneuver. A channel departure training test would occur mainly in ice so the crew could train how to exit from an area once the icebreaker breaks through the ice. The star maneuver is when an icebreaker creates a wider channel, moving forward and backwards (in a star-shaped pattern) to break out of the ice. It would take an icebreaker approximately two days to move into the ice and then testing would last up to six hours (with adjustments). Since the PIB would be in areas of heavy sea ice, the transiting speed would be low (around three knots with a maximum speed of six knots). During this testing the PIB would be using the Doppler Speed Log (see Section 2.1.5).

2.1.3.2.c Bollard Condition Testing (in ice)

Bollard pull or push condition test would occur once per decade in the Arctic proposed action area. “Bollard pull” refers to the pulling (or towing) power of a watercraft, and is defined as the force (in tons or kiloNewtons) exerted by a vessel under full power, commonly measured in a practical test (but sometimes simulated) under certain test conditions (e.g., calm water, ice, etc.). The PIB would sit stationary, secured to a pier, with its engine at full power (a slow increase to full power or a rapid increase to full power), similar to how an automobile revs its engine. The PIB’s engine would work at 110 percent of its power for two hours. After this test is completed, the PIB would need a 24-hour recovery period. “Bollard push” refers to the pushing a large ice feature ahead and astern. This testing may increase noise levels in the immediate testing area, when compared to typical engine noise produced by conventional polar icebreaker operations, due to the engine running at 110 percent. However, if any elevation in noise does occur due to this testing, it would be temporary, lasting only two hours.

2.1.3.3 Escorting and Towing Vessels

The PIB would tow or escort any vessels in need, especially vessels that are stuck in the ice. In the event that a vessel breaks down in the Arctic or Antarctic proposed action areas, the PIB would provide an escort or tow. When escorting a vessel in ice, the PIB would create a channel for the vessel to follow behind it at speeds of 4–5 knots. Emergency escorts or tows are not part of the Proposed Action (see Chapter 1).

2.1.3.3.a Vessel Escort

Based on historical occurrence, the likelihood of a vessel tow or escort in the Arctic is rare, but based on the average number of escorts by other Coast Guard assets in the area, a vessel tow or escort requiring the use of a PIB may occur once per year in the Arctic proposed action area. An Arctic escort may last up to 24 hours. A PIB may perform a convoy escort (escorting multiple vessels) in the Arctic proposed action area, although this is also considered rare based on historical occurrence.

Based on historical locations and average number of escorts by the current fleet of Coast Guard polar icebreakers, a PIB would be expected to escort a vessel an average of two times per year in the Antarctic proposed action area to McMurdo Station. Vessel escorts in the Antarctic proposed action area around McMurdo Station and into the pier located there, may last approximately four hours, but a maximum of

16 hours is possible. It is anticipated that there could be up to 48 hours of additional escorts annually in either proposed action area.

2.1.3.3.b Vessel Tow

The PIB would tow a vessel if needed, but towing a vessel in distress would only be considered as a last resort due to potential safety concerns. The towing of a vessel in distress is considered an emergency (see Chapter 1) and is not part of the Proposed Action. Based on historical operations, towing vessels has occurred only in the Antarctic proposed action area and included: tows to open water occurring once per year, and tows off a pier occurring twice per year. Although it is extremely unlikely, a vessel tow could occur in the Arctic proposed action area, but training is not expected to occur there. Therefore, the PIB crew would conduct annual vessel tow training to carry out Coast Guard missions in the Antarctic proposed action area. In the past, when a polar icebreaker towed a vessel, it was dependent on how far the vessel in distress was from shore and distance to its final destination. The icebreaker's engine typically runs at a quarter power during vessel tow. Speeds of 4–5 knots are typical for a vessel tow and could last up to 48 hours. Icebreaking, if needed, during vessel tow is expected to take less than four hours. It is expected that a new PIB would also perform the same towing actions in a similar manner as those described above based on historical operations and would conduct appropriate training.

Based on historical icebreaker operations, the most common type of vessel tow was pulling a vessel from a pier, which roughly took one hour. Thus, it is expected that a new PIB would also need to pull a vessel off a pier and release it to travel by its own power and the crew would conduct appropriate training. Additionally, every few years at McMurdo Station, an icebreaker also pulls the old pier out to sea. The pier at McMurdo Station is manmade and consists of freshwater and dirt, but other materials include rebar and telephone poles. While the Coast Guard would tow the pier from McMurdo Station out to sea with a new PIB, the Proposed Action only includes the towing off of the pier; the construction and removal and disposal of the pier itself is not part of the Proposed Action as this is not a Coast Guard action.

2.1.3.4 Passenger and Scientist Transfer

A PIB would have landing craft capability. Small support boats deployed off the PIB would bring passengers from the vessel to shore and from the shore to the vessel. Passengers that are transferred may be crew members or scientists and their gear (see Section 2.1.3.7). Passenger transfers would occur over a 12-hour timeframe with two hours spent on the support boat(s). There may be up to two support boats transferring passengers. The support boat travels at a maximum speed of 15 knots. Transfers would typically occur from the PIB when it is no more than 10–12 nm from the port of transfer.

Arctic

In the Arctic proposed action area, there would be both general passenger transfers and scientist transfers. General passenger transfers would occur two times per patrol, typically from the PIB to Nome, Barrow/Utqiagvik, or Dutch Harbor. There would be three scientist transfers expected in the Arctic proposed action area (possibly including one small boat trip near North Pole) per patrol, but the schedule would be dependent on need. The exact location of the scientist transfer is dependent on the research, but details, including impacts to resources, would be covered under the researcher's scientific research permit. During these transfers, Coast Guard would use radar communications, including S-band, commercial off-the-shelf, and antenna (radio).

Antarctic

General passenger transfers and scientist transfers would also occur in the Antarctic proposed action area. General passenger transfers would occur two times per patrol, from the PIB to McMurdo Station, and scientist transfers would also occur two times per patrol. As in the Arctic proposed action area, the exact location of the scientist transfer is dependent on the research, but details, including impacts to resources, would be covered under the researcher's scientific research permit. During these transfers, Coast Guard would use radar communications, including S-band, commercial off-the-shelf, and antenna (radio).

2.1.3.5 Law Enforcement

Law enforcement operations are part of the Coast Guard mission. Law enforcement vessel boardings would occur in the Bering Sea and in the open ocean of the Arctic proposed action area. During the transit portion of each PIB patrol (see Section 2.1.2) there would be approximately two weeks of law enforcement activities. The Coast Guard would deploy up to two over-the-horizon boats from the PIB to board fishing vessels. Over-the-horizon boats would travel less than a mile from the icebreaker at roughly 30 knots. Boarding operations average a maximum of 12 hours. The statutory mission described as living marine resources law enforcement includes the following elements:

- project federal law enforcement presence over the entire U.S. EEZ, covering nearly 3.4 million mi^2 (8.8 million km^2) of ocean
- ensure compliance with fisheries and marine protected species regulations on domestic vessels
- prevent over-fishing, reduce mortality of protected species, and protect marine habitats by enforcing domestic fishing laws and regulations
- enforce the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA)

The statutory mission described as other law enforcement includes the following elements:

- enforce foreign fishing vessel laws
- patrol the U.S. EEZ boundary areas to reduce the threat of foreign poaching of U.S. fish stocks
- monitor compliance with international living marine resource regimes and international agreements
- deter and enforce efforts to eliminate fishing using large drift-nets

Law enforcement missions, including any polar icebreaker support of law enforcement activities, are covered under Title 14 United States Code (U.S.C.) and 6 U.S.C. §468. PIB support of law enforcement activities is considered part of the Proposed Action (e.g., vessel or helicopter activities), including any associated Coast Guard PIB law enforcement training.

2.1.3.6 Search and Rescue Training

Search and rescue missions are those that have the goal of preventing the loss of life and property and typically include a combination of Coast Guard aircraft and vessels. Actual Coast Guard search and rescue missions are considered emergencies, which are not part of the Proposed Action (see Chapter 1). However, crews must be trained for such a response. For example, during an actual search and rescue mission, helicopters (usually only one at a time) are often sent first to locate a vessel in distress and report its status before a Coast Guard vessel is dispatched for rescue (see Section 2.1.4.2) and as part of aircraft training, Coast Guard would train for such a mission. The helicopter would also transport people to safety, if necessary, and personnel may conduct damage control (e.g., plugging holes, patching pipes, or delivering supplies to aid in repair or control on the damage incurred by a vessel in distress). Coast Guard would train in damage control and how to transport people to safety. In addition to the PIB, other support boats may be employed to assist in a search and rescue mission. These support boats could travel at speeds up to 30 knots and it is expected that speeds may reach 30 knots during training, but would not be sustained for the entire training exercise. Search and Rescue (SAR) training on the PIB would include helicopter take-offs and landing from the PIB's flight deck and other associated activities (see Section 2.1.4). SAR training is expected to occur once per year in the Arctic proposed action area and once per year in the Antarctic proposed action area. Training on the PIB would occur over a four-hour timeframe, while helicopter training from the PIB's flight deck would last 12 hours. During all SAR training, navigation technologies would be used, as the vessel would be underway (see Section 2.1.5)

2.1.3.7 Scientific Support Missions

A PIB would have the capability to support science missions either by design or use of a modular concept. Historically, most shipboard polar research has been conducted during the late-spring through early-fall in each of the polar regions. The PIB would serve as a support vessel assisting scientific missions because it is typically stationary in the ice during scientific mission support or in marginal open water in the Arctic and Antarctic proposed action areas. However, historical and existing research has mostly been limited to marginal ice zone areas. Coast Guard support of scientific field research has been more extensive in the Arctic proposed action area due to the proximity of CGC HEALY to research areas of interest and because the CGC HEALY accommodates more scientists than the Coast Guard's Polar Class icebreaker. During all science missions, navigation technologies would be used, as the vessel would be underway (see Section 2.1.5).

2.1.3.8 AUV Deployments

AUV deployment would occur in the Arctic proposed action area two times per patrol. A PIB may deploy AUVs to assist with observing the ice conditions from under the ice, or to patrol living marine resource zones. Operations would likely take place in ice-covered seas. Because of this, AUVs would most likely need to be deployed over the side of the PIB after ice clearing has occurred. AUV deployments would last a maximum of 24 hours, after which the device would be retrieved and brought back onboard the PIB. The PIB would be either stationary or transiting up to three knots during deployment of the AUV. After deployment, the AUV itself can transit at speeds of up to 10 knots. All systems on the AUV would be passive and would not emit any sound into the water.

2.1.3.9 Diver Training

The dive team would only be on the PIB for training purposes, and diver training is expected to occur every other deployment. Diver training would occur to support a variety of PIB maintenance, repair, and protective measures including: husbandry, hull inspections, cofferdam placement and removal, plugging and patching, zinc placement and removal, and hull protection sweeps. Diver activities would last up to two hours and only while the PIB is stationary. Hull protection sweeps would be conducted only when the vessel is at a port on high alert. Husbandry, cofferdam placement and removal, and plugging and patching is expected to occur infrequently. During training, divers would be expected to take pictures of the propeller gear. Hull inspections would occur once per patrol when the PIB moves out of the ice. A PIB would have designated space for a dive locker with a portable hyperbaric chamber to execute dive operations and respond to diving emergencies.

Based on historical and existing locations for diver operations and training, possible locations for diver operations and training on a PIB include Honolulu, Hawaii; Sydney, Australia; McMurdo Station, Antarctica; and Seattle, Washington. In the Antarctic proposed action area, while it is possible for training to occur either in the ice or at the pier in McMurdo Station, almost all diver activities would occur at the pier. Locations close to shore are preferred for diver training and do not occur without small boat support. To maintain proficiency, divers would be expected to train at various locations as the vessel is in transit to the polar region(s): once per month at a warm water location; two times in ice; and, two times a patrol, as needed, during a science mission. Although specific locations in the Arctic proposed action area are unknown at this time, zinc placement and removal would only occur in a port in the Arctic proposed action area and not in the Antarctic proposed action area.

2.1.3.10 Fueling Underway

A PIB would have the capability to refuel alongside another vessel, although rare, typically occurring once every five years. Fueling would last up to three hours and could occur in the Arctic and Antarctic proposed action areas. The PIB would receive one or more fuel lines from another vessel (most likely an oil tanker) that is not underway. The lines would be passed from the supply vessel to the PIB to be connected. While refueling, crew fasten fuel lines to the vessel’s fuel pipes and closely monitor the transfer firsthand as fuel passes through a polar icebreaker’s fuel system into the tanks. Crew would constantly survey the fuel transfer and have preventative as well as reactive safety plans in place should a fuel spill occur. Spill kits would be on hand in case of an emergency. While the two vessels are connected, they would both remain stationary. In the Antarctic proposed action area, fuel can be pumped from the PIB to an established location at Marble Point. In this event, the PIB would also be stationary and connected to fuel lines at Marble Point.

2.1.3.11 Gunnery Training

Gunnery training would occur at least 12 nm from shore and potentially in an established U.S. Navy range. The preferred location is in the open ocean, likely in the Pacific Northwest proposed action area. Gunnery training in the Bering Sea would be considered rare and unlikely to occur due to prevailing weather conditions. Gunnery training is expected to occur two times per year. During gunnery training, a PIB would fire inert (i.e., non-explosive) small caliber, 0.50 caliber or MK-38 standard rounds (25 millimeter [mm]), gun rounds. A PIB is expected to have four gun mounts. Each mount would fire between 50 and 250 rounds during training exercises. Because gunnery training is expected to occur two times per year, there would be a maximum of 500 small caliber rounds expended annually as a result of this training. Rounds may be fired at a “killer tomato” target, a 10 foot (ft; 3 meter [m]) diameter red balloon, which would not be retrieved. The entire training would take over an hour, but the actual firing of gun rounds would take approximately 30 minutes. During training, the PIB would be transiting between 6 and 10 knots.

A PIB would also carry MK-38 standard system rounds, which are high explosive rounds. MK-38 standard system rounds are for use only during emergencies and not during training and thus, are not part of the Proposed Action. Therefore, MK-38 system rounds are not discussed further in this PEIS.

2.1.3.12 Marine Environmental Response Training

Oil spill training field exercises would occur onshore (classroom and practical training) or in the nearshore area (practical open-ocean training) in the Alaskan port of Barrow/Utqiagvik or near Norton Sound near Nome, Alaska in the Arctic proposed action area and in the Pacific Northwest proposed action area, specifically in Puget Sound, Washington. Training would occur two times per year. A PIB would conduct actual marine environmental response if there were an oil spill in the ocean; however, the response itself is covered under [the Interagency Memorandum of Agreement Regarding Oil Spill Planning and Response Activities Under the Federal Water Pollution Control Act’s National Oil and Hazardous Substances Pollution Contingency Plan and the ESA] and not part of the Proposed Action. The primary focus of this training exercise is to provide both classroom and practical training consistent with the State and Federal Unified (Response) Plan Geographic Response Strategies and that includes onshore and at-sea training. While an actual marine environmental response would only occur in the event of an emergency, the recovery gear would need to be tested annually. Testing the gear and training personnel would involve deploying a floating U-shaped boom on the water’s surface. During an actual emergency, the boom would be attached to a pump and used to corral oil, which would then be pumped into a tank on a PIB. During the equipment training, the boom would be deployed into the water and the pump may pump seawater onto the PIB to test the pump’s functionality. In addition, marine environmental response training would involve the use of a small support boat that is either stationary or transiting at slow speeds (up to 3 knots), while the PIB would be stationary. This part of the training would only occur in open water, and would occur over a three- to five-hour timeframe.

2.1.4 Aircraft Operations

A PIB would be a Flight Deck Equipped Cutter with the ability to launch, recover, hangar, and maintain manned and unmanned aircraft. Helicopters supporting a PIB would either fly from shore to the icebreaker or from the icebreaker to shore, though some flights would be expected to depart and then return to a PIB without heading to shore. Typically, aircraft operations would occur closer to shore because they are departing from an established FOL (Figure 2-2) in the Arctic proposed action area or from a PIB to shore in the Antarctic proposed action area.

2.1.4.1 Landing Qualifications

Daytime landing qualifications would occur approximately two times per patrol in the Arctic proposed action area and two times per patrol in the Antarctic proposed action area. Daytime landing qualifications, would involve approximately 15 helicopter take-offs and landings from a PIB’s flight deck, and would be conducted every month when the vessel is in transit, as part of the patrols. Qualifications would occur over a four-hour period. Some qualifications (around 25 percent) would be expected to occur at night. Helicopter pilot and crew receive qualification training prior to deployment, but that training is not covered in this PEIS.

2.1.4.2 Reconnaissance

Helicopters would conduct reconnaissance flights to detect open water leads in the ice and communicate this information to other assets in the area (e.g., an open water lead is an area where a PIB can more easily transit). The primary aircraft expected to be used for ice reconnaissance during the Proposed Action is the MH-60 Jayhawk helicopter; however, the Coast Guard may also use unmanned aerial vehicles (UAVs) for ice reconnaissance. Flight altitudes could range between 400–1,500 ft (122–457 m) and would follow Standard Operating Procedures (SOPs); see Chapter 6) for aircraft altitudes. Ice reconnaissance would occur over a two-hour timeframe, in the Arctic and Antarctic proposed action areas. Ice reconnaissance would be conducted two times per patrol in both areas.

2.1.4.3 Vertical Replenishments and Mission Support

Vertical replenishments and mission support would occur two times during a patrol in the Arctic proposed action area and once per patrol in the Antarctic proposed action area. Arctic support activities would most likely occur out of Barrow/Utqiagvik, Alaska and Antarctic support activities would occur out of McMurdo Station. During vertical replenishment and mission support, helicopters (generally staged on land at an established FOL) would deliver supplies to the PIB. This requires 8 hours of flight time as well as 8 hours on the flight deck of the PIB, for a total of 16 hours per replenishment.

2.1.4.4 Community Outreach and Passenger Transfer

In the Arctic proposed action area, community outreach operations would occur two times per patrol. During transfers and community outreach from the PIB, helicopters would transport passengers (crew) and scientists and their gear on and off a PIB. In the Arctic proposed action area, these transfers would occur two times per patrol. Transfers would occur over a two-hour timeframe. This includes 4 round trips (30 minutes each) per evolution.

Passenger transfers in the Antarctic proposed action area would occur four times per patrol. The timeframe of the transfers would be the same in the Antarctic proposed action area as the Arctic proposed action area (2-hour timeframe which includes 4 round trips [30 minutes each] per evolution). No community outreach operations would occur in the Antarctic proposed action area.

Table 2-2. Activity Names, Locations, and Frequency

Activity[1]	Proposed Action Area(s)	Frequency per year	Hours per activity
Icebreaking Full Power[2]	Arctic	5	Up to 16
	Antarctic	4	Up to 16
Icebreaking Half Power[2]	Arctic	5	Up to 16
Icebreaking Quarter Power[2]	Arctic	11	Up to 16
	Antarctic	22	Up to 16
Maneuverability – Propulsion Testing (Sea Trials)	Pacific Northwest	1	Up to 2[3]
Maneuverability – Propulsion Testing (Post Delivery Trials)	Pacific Northwest	1	Up to 2[3]
Maneuverability – Ice Condition testing	Arctic	1 time every 10 years	Up to 6[3]
Maneuverability –(In Ice) Bollard Condition Testing	Arctic	1 time every 10 years	2
Vessel Escort	Antarctic	2	4– 16
	Arctic	1	24
	Antarctic/Arctic	1	48
Vessel Tow	Antarctic	1	1–48
Vessel Operations: Passenger Transfer	Arctic	5	Up to 12
	Antarctic	4	Up to 12
Vessel Operations: Law Enforcement	Arctic (Bering Sea)	20	Up to 12
SAR Training	Arctic	1	4–12
	Antarctic	1	4–12
AUV Deployments	Arctic	2 times per patrol	Up to 24
Diver Training	Pacific Northwest	To maintain proficiency: 1 time/month (warm season) In ice: 2 times /deep freeze For science: 2 times/patrol	2
	Antarctic		
	Arctic		
Fueling Underway	Arctic	1 time every 5 years	3
	Antarctic		

Activity[1]	Proposed Action Area(s)	Frequency per year	Hours per activity
Gunnery Training	Pacific Northwest (Open Ocean or Navy Range)	2	1
Marine Environmental Response Training	Pacific Northwest	2	3–5
	Arctic		
Aircraft Operations: Landing Qualifications[4]	Arctic	2	Flight operation duration: 4 hours. Qualification evolution: 1 day
	Antarctic	2	
Aircraft Operations: Ice Reconnaissance[4]	Arctic	2	2
	Antarctic	2	2
Aircraft Operations: Vertical Replenishment and Mission Support[4]	Arctic	2	16
	Antarctic	1	16
Aircraft Operations: Community Outreach, Passenger Transfer[4]	Arctic	4	2–4
	Antarctic	4	2–4

[1] Patrols would encompass all activities listed in table.
[2]Icebreaking is dependent on ice cover. Days provided in this table are based on averages from past years. Actual icebreaking days may vary from estimates above.
[3]Maneuverability testing would be 2–6 hours (depending on activity) and may occur on two consecutive days.
[4]Helicopters would likely be the aircraft supporting these activities.

2.1.5 Acoustic Sources

The Proposed Action would include the introduction of sound in water and air. In-water sources of sound include underwater acoustic transmissions, vessel noise (engine and other operational equipment noises made by the vessel), icebreaking (engine noises made while icebreaking—different than those made while underway in only water—as well as the sound created by breaking ice), and helicopter noise (both in-air and the in-air to water surface transfer) from aircraft operations. The Coast Guard proposes to adopt the U.S. Navy's "*de minimis*" definition for those acoustic sources that meet the criteria discussed below. Sources that either do not meet the *de minimis* definition or require further analysis are discussed in detail in Chapter 4.

De minimis

The Coast Guard proposed to adopt the U.S. Navy's definition of acoustic sources, defined as *de minimis* (U.S. Navy 2013) as any in-water active acoustic source with: narrow beam widths; downward directed transmissions; short pulse lengths; frequencies outside known hearing ranges (e.g., marine mammals); low source levels; or a combination of any of these factors. A *de minimis* acoustic source is not expected to result in take of protected species. These *de minimis* sources are qualitatively analyzed to determine the appropriate determinations under NEPA in the appropriate resource impact analyses, as well as under the MMPA and the ESA, where applicable. When used during routine activities and in a typical environment, *de minimis* sources fall into one or more of the following categories:

- Transmit primarily above 200 kilohertz (kHz): Sources above 200 kHz are above the hearing range of the most sensitive marine mammals and far above the hearing range of any other animals in the proposed action areas.
- Source levels of 160 decibels referenced at 1 micropascal (dB re 1 µPa) or less: Low-powered sources with source levels less than 160 dB re 1 µPa are typically hand-held sonars, range pingers, transponders, and acoustic communication devices. Assuming spherical spreading for a 160 dB re 1 µPa source, the sound will attenuate to less than 140 decibels (dB) within 33 ft (10 m) and less than 120 dB within 100 m (328 ft) of the source. Ranges would be even shorter for a source less than 160 dB re 1 µPa source level.
- Sources with operational characteristics (such as short pulse length, narrow beam width, downward-directed beam, and low energy release, or manner of system operation), which exclude the possibility of any significant impact to a protected species. Even if there is a possibility that some species may be exposed to and detect some of these sources, any response is expected to be short-term and inconsequential.

All Coast Guard vessels, including icebreakers, are equipped with standard navigational technologies, including fathometers, radar and navigational sonar. The single beam echosounder (fathometer) is part of the vessel's navigation system that would be on at all times while a vessel is underway (potentially up to 24 hours). The fathometer frequencies (Table 2-3) can range from 3.5–1,000 kHz; however, most navigational systems operate from 50–200 kHz, which is the assumed operating frequency for the Proposed Action.

Transmitted pulses from the fathometer are of short duration, typically milliseconds, but are operational for the entire time a vessel is underway. The maximum transmit powers may be as high as 227 decibels referenced at 1 micropascal at 1 meter (dB re 1 µPa @ 1 m), depending on frequency (the highest levels are used in low-frequency deep-water applications), but during the Proposed Action the source level is not expected to be higher than 205 dB re 1 µPa @ 1 m. The most common geometry is one conical vertical beam, with sidelobes that may generate unwanted energy outside of the main lobe, but are typically 20 dB to 30 dB below the main lobe's level. The pulse durations are normally about 0.1 percent to 1 percent of the echo reception delay, hence typically between 0.1 and 10 milliseconds, with longer pulses corresponding to lower frequencies and deep waters. Based on the short pulse length, narrow beam width, downward-directed beam, and manner of system operation, and the *de minimis* criteria, the navigational system (i.e. fathometer/single beam echosounder) could be considered *de minimis*. Underwater acoustic sources associated with sea operations and training, specific to vessel type are listed in (Table 2-3). However, for some biological resources, the frequency range (50–200 kHz) does overlap with the hearing range of certain species, and the potential impact of that overlap with hearing is discussed in greater detail in Section 4.1.1.

The Acoustic Doppler Current Profiler (ADCP) is an instrument used by researchers to measure how fast water is moving across an entire water column. The ADCP would be either hull-mounted, towed near the surface, or attached to a mooring that also has passive scientific sensors. The ADCP measures water currents with sound, using the Doppler Effect. A new PIB would be modulated for an ADCP, but may not necessarily have one onboard. An ADCP's primary use is for research purposes only and not for Coast Guard operations. Therefore, the ADCP is not analyzed further in this PEIS.

Table 2-3. Underwater Acoustic Sources Associated with Sea Operations and Training

Source type	Frequency range [kHz]	Source level (dB re 1 µPa @ 1 m)	Associated Action
Small vessel	1–7	175	Small boat training, routine patrols
Large vessel	0.02–0.30	190	All sea operations and training
Icebreaking*	0.01–0.1	205	Icebreaking activities
Single-beam echosounder (Fishfinder, Depth Sounder)	3.5–1,000 (24–200)[a]	205[b]	All sea operations and training, research and development

re 1 µPa @ 1 m: referenced to 1 microPascal @ 1 meter for underwater sound
*Section 4.1.4 and Appendix B describe how icebreaking noise was modeled for the purposes of the analysis in this PEIS.
[a] Typical frequency range for most devices that are commercially available
[b] Maximum source level is 227 decibels root mean square @ 1 meter, but the maximum source level is not expected during operations
References: (NMFS 2012a; Richardson et al. 1995; U.S. Coast Guard 2013a)

2.2 Alternatives

As required by NEPA, the Coast Guard evaluated alternatives to the PIB project to determine whether an alternative would be environmentally preferable and/or technically and economically feasible to the Proposed Action while still meeting the project objectives. The Coast Guard evaluated the no-action alternative and a leasing alternative. These alternatives were evaluated using a specific set of criteria. The evaluation criteria applied to each alternative include a determination whether the alternative:

- meets the objectives of the Proposed Action
- is technically and economically feasible and practical
- offers a significant environmental advantage over the Proposed Action

2.2.1 Alternative 1: Preferred Alternative

Based on all the alternatives analyzed, new construction is the preferred alternative. Under Alternative 1, the Coast Guard would design and build up to six PIBs to fulfill mission requirements in the Arctic and Antarctic. The first of the newly constructed PIBs would be a heavy icebreaker to be commissioned as soon as 2023, the same year CGC POLAR STAR is scheduled for decommissioning. After the first PIB is constructed and commissioned into the Coast Guard fleet, up to five additional PIBs could be constructed and commissioned. It would take approximately 12–18 months to commission each subsequent PIB into the Coast Guard's PIB fleet. This schedule would allow for CGC POLAR STAR and CGC HEALY to be decommissioned at the end of each of their designed service lives, and the Coast Guard to remain present with no delay in service in the Arctic and Antarctic to complete the Coast Guard's missions.

2.2.2 Alternative 2: Leasing

Under the Leasing Alternative, the Coast Guard would explore various forms of icebreaker leasing, such as those leases used by the U.S. Navy, the National Science Foundation (NSF), other federal agencies, and the domestic maritime industry, to close the Coast Guard icebreaking capability gap. The leasing alternative was analyzed in detail through previous studies, first in the early 1980s and again in 2011 (Schnappinger and ABS Consulting 2011). This analysis re-visited the leasing option to investigate whether any of the underlying conditions had changed. The analysis included consideration of pre-determined, fixed-price, long-term leasing arrangements, demise charters, and contractor-owned, contractor-operated charters.

An analysis of this alternative, conducted during the Polar Platform Business Case Analysis (USCG Research and Development Center 2010), noted that both the Department of Defense and other Federal organizations have used leases and charters to fill capability gaps and that these options were often deployed when procurement funding levels were insufficient to address mission requirements and allowed the lessee to avoid large, up-front obligations of procurement funds. Several drawbacks to the leasing alternative are noted in the Polar Platform Business Case Analysis, including the lack of an existing domestic commercial vessel capable of meeting available options to Purchase and Build-to-Lease. The investigation revealed that the previous conditions that were analyzed had not changed, for the same principal reasons listed below:

- There are no existing vessels available for lease that substantially meet the Operational Requirements Document.
- Office of Management and Budget guidance (A-11, A-94) mandates that a Capital Lease would be required for a purpose such as this alternative. As a Capital Lease, both Office of Management and Budget guidance and U.S. Code would require that the lease be a demise (i.e., bareboat) charter due to the missions the Coast Guard must execute with the vessel, including

planned operations in support of defense readiness and mission tasks involving law enforcement and port, waterways, and coastal security.

- In addition, under international law and U.S. Code, the vessel would need to be on a demise charter to the Coast Guard in order for a leased vessel to be authorized to conduct National Defense and Freedom of Navigation operations, which require the vessel to be internationally recognized as a warship.

2.2.3 Alternative 3: No Action Alternative

The evaluation of a No Action Alternative is required by the regulations implementing NEPA (40 CFR 1502.14(d)). Under the No Action Alternative, the Coast Guard would fulfill its missions in the Arctic and Antarctic using existing assets, which are reaching the end of their service lives. The existing assets would continue to age, causing a decrease in efficiency of machinery as well as an increased risk of equipment failure or damage, and would not be considered reliable for immediate emergency response. In addition, it may become more difficult for an ageing fleet to remain in compliance with environmental laws and regulations and standards for safe operation. A major overhaul or reconstruction of the two Coast Guard Polar Class icebreakers was analyzed in depth in a 2010 congressionally mandated independent study, the Coast Guard Polar Platform Business Case Analysis. That study concluded major overhaul of the two existing polar icebreakers would not permit the polar icebreakers to meet all of the Operational Requirements Document threshold requirements nor new environmental regulations (USCG Research and Development Center 2010). Specifically, the double hull requirements to comply with current regulations cannot be achieved by overhaul. In addition, further Service Life Extensions become more challenging as significant systems and parts are no longer available, which requires contracting for systems or parts to be made specifically for the vessel. The high strength steel used for the hull required specialty welding skills and is no longer used in the ship construction industry. Trying to match that steel for re-construction would be extremely difficult; adjoining with dis-similar steel can compound stress concentrations at the interfaces. The Coast Guard has recognized a future capability gap in its icebreaking mission. This future capability gap is forming while assets that perform the icebreaking function are nearing the end of their effective or extended service lives. If current trends continue, the Coast Guard may lose all heavy icebreaking capability by 2023 and medium icebreaking capability by 2030. Without the construction and deployment of new PIBs, the Coast Guard would not be able to maintain a presence in the Arctic and Antarctic Regions once the current fleet is decommissioned.

The No Action Alternative would also not meet the Coast Guard's statutory mission requirements in the Arctic or Antarctic by providing air, surface, and shoreside presence in the polar regions. The Coast Guard also enforces the MMPA and ESA, and without reliable Coast Guard presence, enforcement of these laws would be significantly reduced. As such, the No Action Alternative does not meet the purpose and need, but is included here for comparison of environmental effects with the Preferred Alternative.

2.2.4 Alternatives Considered Then Eliminated from Analysis

In the High Latitude Mission Analysis report, the Coast Guard analyzed their ability to complete their missions in polar regions using their current available assets. Analysis of the Arctic mission focused on meeting the most basic Coast Guard roles – protecting the environment and supporting missions, and contingency response in and around Alaska. Based on projected Arctic trends, analysis shows the current Coast Guard deployment posture is not capable of effective response in northern Alaska and that response may be improved through a mix of deployed cutters, aircraft, and supporting infrastructure including FOLs and communications/navigation systems. Analysis of the Antarctic mission capabilities concluded that deficiencies are most pronounced in the Defense Readiness and Ice Operations missions. The High Latitude Mission Analysis report concluded that a mix of FOLs, aircraft, communications infrastructure, and ice capable ships (including some classified as icebreakers) would be required, depending on the level of mission demand and performance desired. Thus, in order to complete high latitude mission requirements, the Coast Guard would need ice capable vessels in their fleet.

Other action alternatives considered but not carried forward for detailed analysis include geographic, seasonal, and operational variations. Polar icebreakers cannot be stationed in different locations because they need to be near ports that can dock a large vessel and to perform icebreaking activities in proximity to ice-covered seas. Alternative locations would not meet the purpose and need of the Coast Guard's missions. The requirement for the Coast Guard to be present in the Arctic is necessary in the Bering, Chukchi, and Beaufort Seas to be able to react quickly to matters requiring Coast Guard response, such as safety of life at sea, law enforcement, and marine collisions. The Coast Guard presence in the Antarctic is necessary to support McMurdo Station Antarctic logistics, which allows other vessels to access the pier. The Pacific Northwest proposed action area may be changed, but a feasibility study has not yet been conducted and this is one of the few locations with the capacity to dry-dock a large vessel, such as a PIB. Seasonal alternatives are likewise not feasible because, in order to provide essential services to vessels in need, polar icebreakers may need to be in the Arctic year-round. A polar icebreaker needs to be in the Antarctic in the austral summer to support McMurdo Station Antarctic logistics.

Finally, altering how a polar icebreaker conducts operations and training is not feasible because the operational and training plans are designed to specifically meet or test certain objectives. Conducting operations and training differently would not meet the purpose and need of these requirements. Therefore, the proposed action areas identified in Figure 2-1, Figure 2-3, and Figure 2-4 are the only suitable locations. Year-round and austral summer operations and testing in the Arctic and Antarctic, respectively, are the only suitable timeframes. Additionally, the Proposed Action must be conducted as proposed to meet Coast Guard operational and training requirements.

2.3 RESOURCE ANALYSIS

As part of the process to determine the potential impacts from the Proposed Action, the Coast Guard identified potential resources and issues to analyze (Table 2-4). Specific resources eliminated from further consideration are listed in Table 2-5, which includes the reasoning for their removal from further analysis. For example, wild and scenic rivers were eliminated because the Proposed Action does not overlap with these resources. Others, such as air and water quality and environmental justice, were eliminated from further consideration because the Coast Guard intends to follow all laws and regulations, resulting in no impacts to these resources.

Table 2-4. Relevant Resources and Potential Effects from the Proposed Action

Resource	Potential Impacts
Physical Environment	
Bottom Habitat and Sediment	MEM has the potential to impact or harm bottom habitats or sediment in the Pacific Northwest and Arctic proposed action area. Gunnery training (e.g., MEM) would not occur in the Antarctic proposed action area, therefore, potential impacts from MEM were not analyzed in the Antarctic proposed action area.
Sea Ice	Only icebreaking has the potential to impact or harm sea ice in the Arctic and Antarctic proposed action areas. However, impacts to sea ice were not analyzed in the Pacific Northwest proposed action area because it does not exist there.
Biological Environment	
Marine Vegetation	Only MEM has the potential to impact or harm marine vegetation in the Arctic and Pacific Northwest proposed action areas.
Invertebrates	Vessel noise, icebreaking noise, vessel movement, AUV movement, and icebreaking have the potential to impact or harm invertebrates in the proposed action areas. Effects from aircraft would not impact invertebrates because there is no overlap. Effects from underwater acoustic transmissions would not impact invertebrates because the sound would attenuate before reaching areas where invertebrates may be distributed in the proposed action areas. Therefore, impacts to invertebrates from aircraft movement, aircraft noise, and underwater acoustic transmissions were not analyzed.
Fish	Underwater acoustic transmissions, vessel noise, icebreaking noise, vessel movement, AUV movement, icebreaking, and MEM have the potential to impact or harm fish in the proposed action areas.
EFH	Underwater acoustic transmissions, icebreaking, and MEM have the potential to impact or harm EFH in the Arctic and Pacific Northwest proposed action areas. EFH has not been designated in the Antarctic proposed action area and therefore, impacts to EFH were not analyzed.
Seabirds	Vessel noise, icebreaking noise, aircraft noise, gunnery noise, vessel movement, aircraft movement, AUV movement, and icebreaking, have the potential to impact or harm seabirds in the proposed action areas. MEM has the potential to impact or harm sea turtles in the Arctic and Pacific Northwest proposed action areas.
Sea Turtles	Underwater acoustic transmissions, vessel noise and vessel movement have the potential to impact or harm sea turtles in the Arctic and Pacific Northwest proposed action areas. Sea turtles are not found in the Antarctic proposed action area. Icebreaking, AUV movement, and aircraft activities would not overlap with sea turtle distribution, therefore impacts to sea turtles from icebreaking, icebreaking noise, AUV movement, aircraft movement, and aircraft noise were not analyzed.
Marine Mammals	Underwater acoustic transmissions, vessel noise, icebreaking noise, aircraft noise, vessel movement, AUV movement, and icebreaking have the potential to impact or harm marine mammals within the proposed action areas. MEM has MEM has the potential to impact or harm marine mammals in the Arctic and Pacific Northwest proposed action areas.

Resource	Potential Impacts
Socioeconomic Environment	
Commercial and Recreational Fishing	The Proposed Action has the potential to impact commercial and recreational fishing in the proposed action areas.
Research, Transportation, Shipping, and Tourism	The Proposed Action has the potential to impact research, transportation, shipping, and tourism in the proposed action areas.
Subsistence Hunting	The Proposed Action has the potential to impact subsistence hunting in the Arctic and Pacific Northwest action areas. No subsistence hunting occurs in the Antarctic proposed action area and therefore, impacts to subsistence hunting were not analyzed.

EFH: Essential Fish Habitat; MEM: Military Expended Materials

Table 2-5. Resources Eliminated from Analysis

Resource	Potential Impacts
Physical Environment	
Air Quality	The Proposed Action would generate air emissions from aircraft and vessels, but the action is not subject to the General Conformity Rule because the coastal regions of Alaska and Washington are in attainment of the National Ambient Air Quality Standards for criteria pollutants. Air emissions would be minimal and of short-duration, and they would be generated at sea, away from the general public. Therefore, the Proposed Action would not impact or harm air quality.
Airspace	The majority of aircraft use associated with the Proposed Action would occur over the water or at existing airstrips. Low flying aircraft may be used for a portion of the training and testing but would not interfere with regular public airspace usage given that the offshore locations are within an infrequently used flight corridor. Therefore, the Proposed Action would not impact or harm 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 or harm floodplains or wetlands.
Geology	No construction or dredging is planned as part of the Proposed Action. Therefore, the Proposed Action would not impact or harm geological resources.
Land Use	The Proposed Action would occur offshore of Alaska, Washington, and Antarctica on water and at existing airstrips. Therefore, the Proposed Action would not impact or harm land use.
Terrestrial Environment	The Proposed Action would primarily occur offshore. Onshore portions of the Proposed Action include outreach and education, and classroom/practical training. Therefore, the Proposed Action would not impact or harm the terrestrial environment including parks, forests, and prime and unique farmland.
Water Quality	Coast Guard vessels are mandated to comply with the Clean Water Act. Any discharges from vessels are conducted pursuant to the Clean Water Act as well as the Ocean Dumping Act. Therefore, the Proposed Action would not impact or harm water quality.
Wild and Scenic Rivers	The Proposed Action would occur on or in ocean waters. Therefore, the Proposed Action would not impact or harm wild and scenic rivers.
Biological Environment	
Deep Sea Corals and Coral Reefs	The Coast Guard would not cause bottom disturbance in areas that contain deep sea corals and coral reefs. Therefore, the Proposed Action would not impact or harm deep sea corals or coral reefs.
Terrestrial Wildlife	No impact to terrestrial habitat is expected as a result of the Proposed Action. Ambient noise levels are not expected to increase at existing airstrips as a result of the Proposed Action. The majority of flights would occur between existing airstrips and the open ocean. Therefore, no impact or harm to terrestrial wildlife is anticipated.
Socioeconomic Environment	
Aesthetics	Aircraft would arrive and depart from existing airports and airstrips and would be consistent with the typical flights coming in and out of these areas. Vessel movements would be off shore and would be consistent with other vessels operating within the proposed action areas. Therefore, the Proposed Action would not impact or harm aesthetics.

Resource	Potential Impacts
Archaeological/Historical Resources	No archaeological or historical resources are located within the proposed action areas. Therefore, the Proposed Action would not impact archaeological and historical resources.
Cultural Resources	Coast Guard would avoid cultural resources in the proposed action areas. Therefore, the Proposed Action, would not impact cultural resources.
Environmental Justice	Federally recognized tribes in the Arctic and Antarctic proposed action areas would be invited to consult on the Proposed Action for those activities that may concern Indian Tribal self-government, trust resources, and Indian Tribal treaty and other rights. The Proposed Action would occur on the water and there would be no disproportionately high or adverse human health or environmental impacts on minority or low-income populations. Therefore, the Proposed Action would not impact or harm environmental justice.
Infrastructure	No modification of infrastructure would occur as a result of the Proposed Action. Therefore, the Proposed Action would not impact or harm infrastructure.
Utilities	The Proposed Action would not occur near any utilities. Therefore, the Proposed Action would not impact or harm utilities.

CHAPTER 3 EXISTING ENVIRONMENT

This chapter describes the existing environmental setting and establishes baseline conditions for the resources that have the potential to be directly or indirectly affected by the Proposed Action. This chapter is organized by resource topic, specifically defined for each proposed action area, with a detailed description of individual resources, in the applicable proposed action area. The discussion also includes an overview of related existing environmental conditions.

In accordance with CEQ guidance 40 CFR 1501.7(3), only resources that have the potential to be affected are discussed in this PEIS. Table 2-5 lists the resources that will not be evaluated. Although, the Coast Guard will work toward environmental compliance prior to the design and build of the icebreaking vessel, the a PIB is not expected to potentially impact the environment or biological resources until it is built, deployed and operational. The first new PIB may be operational as soon as 2023, as such, the Coast Guard acknowledges that new information about the existing environment may become available before 2023, but after the publication of this PEIS. Therefore, the Coast Guard presents the best available information on the existing environment in this PEIS, but anticipates that there may be supplemental environmental assessments prepared in support of individual proposed actions as new information is provided and tiered to this PEIS. In addition, significant impact or harm from vessel homeporting, maintenance, and decommissioning would be analyzed in a supplemental document once more information about these plans becomes known.

3.1 PHYSICAL ENVIRONMENT

The Proposed Action would occur on the surface of the water, underwater (e.g., diver training), and in the airspace above the proposed action areas. Protocols and equipment incidental to the normal operation of a Coast Guard vessel would follow all regulations in order to comply with state and federal laws regarding pollution of air and water. With the exception of inert bullets used as part of gunnery training (see Section 4.2.5), no foreign substances or materials would be released into the air or water as part of the Proposed Action, nor would physical habitats be damaged or permanently altered by noise or vessel and aircraft movement within the proposed action area. Therefore, no significant impact or harm is anticipated to the physical environment as a result of the Proposed Action.

While the Proposed Action would generate air emissions from both aircraft and vessels, these are few in number, and widespread within the proposed action areas. Air emissions would be minimal, of short-duration, and generated at sea, away from the public. Because the current air quality in the proposed action areas is not poor, emissions from the aircraft and vessels associated with the Proposed Action would not constitute a significant impact to the air quality in these proposed action areas. At the proposed level of intensity, emissions from these assets would not result in significant impacts. In addition, the Proposed Action is not subject to the General Conformity Rule because the coastal regions of Alaska and Washington, where aircraft and vessels are operating, are in attainment of the National Ambient Air Quality Standards for criteria pollutants. Therefore, air quality is not evaluated further in this document.

The Coast Guard would follow all existing rules and regulations protecting water quality and the safe handling of any products of the normal operations of the icebreaking vessel including but not limited to bilge water, ballast water, and wastewater. As part of the Proposed Action, no additional discharge or substances would enter the water column that is not already accounted for as those that are incidental to the normal operation of a vessel. Therefore, water quality is not further evaluated in this document.

3.1.1 Bottom Habitat and Sediments

Section 3.1.1.1 and Section 3.1.1.2 describe the Arctic and the Pacific Northwest proposed action areas in further detail, respectively. Below is a description of bottom habitat and sediments relative to the Arctic and Pacific Northwest proposed action areas. The Proposed Action is not expected to significantly impact or harm bottom habitat and sediment in the Arctic or Pacific Northwest proposed action areas. No proposed activities associated with the Proposed Action are expected in the Antarctic proposed action area and is therefore not evaluated further.

3.1.1.1 Arctic Proposed Action Area

The continental shelf within the Arctic proposed action area is extremely wide and nearly horizontal. This is in stark contrast to the neighboring deep-sea basin. The Bering Sea's main features are the Aleutian Basin, several seamounts and islands, Bower's Ridge and Basin, and the bordering Aleutian Islands (Figure 3-1). The basins within the Bering Sea average a maximum depth of 13,123 ft (4,000 m) (National Oceanic and Atmospheric Administration (NOAA) 2004). The Bering Sea is a moderately high productivity ecosystem currently undergoing a climate driven change in species dominance and abundance (Protection of the Arctic Marine Environment (PAME) 2013). The only gateway between the Pacific and the Arctic is the Bering Strait, a narrow, shallow passageway 46 nm wide and 164 ft (50 m) deep (Woodgate 2013). Due to the width of this passage, it is only an inflow point. Cold, less saline water (averaging about 32.5 practical salinity units) enters the Bering Strait from the Pacific Ocean and flows to the Arctic (Woodgate et al. 2005).

The dominant bathymetric features of the Chukchi Sea are the relatively shallow depths of Hanna (average depth 148ft) and Herald Shoals (average depth 23 ft)(National Oceanic and Atmospheric Administration 2008). During the winter, winds from interior Alaska blow over the shallow Chukchi Sea, freezing the water into ice and moving the ice away from land. This process is constantly creating and moving ice as well as leaving behind salt, causing the dense, cold water to sink into the western Arctic. The cold, salty water from the Pacific shelf, lying atop the warmer, saltier water (about 35 practical salinity units) from the Atlantic Ocean creates the Arctic halocline. This halocline prevents the warm, dense bottom water from melting the polar ice from below (Woods Hole Oceanographic Institution 2006). Throughout the Arctic, a cold halocline layer is important in providing a density barrier trapping heat at depth from the Atlantic and away from the ice.

The Beaufort Sea, east of Barrow/Utqiagvik, contains many coastal shoals and islands (National Oceanic and Atmospheric Administration 2006). The primary bathymetric feature is the Canada Basin, which averages a depth of 12,500 ft (3,810 m) (Ostenso 2014). The high Arctic waters (a term used to describe barren polar areas) have water of relatively low nutrient loads. Nutrient concentrations undergo seasonal depletion in surface waters due to photosynthesis during spring/summer and renewal during winter when photosynthesis stops (Vancoppenolle et al. 2013).

The central regions of the northern Bering Sea are characterized by fine and very fine sand, with coarser grained sand, gravel, and cobbles near the outer boundaries of the northern Bering Sea and Bering Strait (Grebmeier et al. 1989; Logerwell et al. 2015). Sediments in the Chukchi Sea are characterized by more heterogeneous fine sand/silt and clay. The Alaskan Beaufort Sea shelf is narrower than the Chukchi Sea shelf and relatively flat. Bottom depths increase gradually from the coast to the 262.5 ft (80 m) isobath, then drop off rapidly along the shelf break and slope. Soft corals and sponges dominate the bottom of the Bering Sea.

3.1.1.2 Pacific Northwest Proposed Action Area

The continental shelf off Washington extends seaward of the shoals and inlet channels, and includes an abundance of coarse-grained, soft bottom habitats. Finer-grained sediments collect off the shelf break, continental slope, and abyssal plain. These areas are inhabited by soft-sediment communities of mobile invertebrates fueled by benthic algae production, chemosynthetic microorganisms, and detritus drifting through the water column.

The Pacific Northwest Proposed Action Area is located on the eastern edge of the Cascadia Basin (Figure 2-4). This abyssal plain is a nearly flat area that begins approximately 375 nm off the West Coast of Washington and northern Oregon that extends to the Juan de Fuca Ridge. The eastern edge of the basin is a subduction front between the North America and the Juan de Fuca plates. Abyssal plains can be described as large and relatively flat regions covered in a thick layer of fine silty sediments with the topography interrupted by occasional mounds and seamounts (Kennett 1982; Thurman and Burton 1997). The basin slopes to the south and reaches a maximum depth of 2,930 m (9,613 ft) (Underwood et al. 2005). The active subduction zone and submarine canyons extend from the continental shelf, creating thick fans of sediment in the basin, and the northern edge of the Nitinat Fan lies within the proposed action area. The abyssal plain and similar deep water areas were originally thought to be devoid of life; however, recent research has shown that these areas are host to thousands of species of invertebrates and fish (Beaulieu 2001; O'Dor 2003).

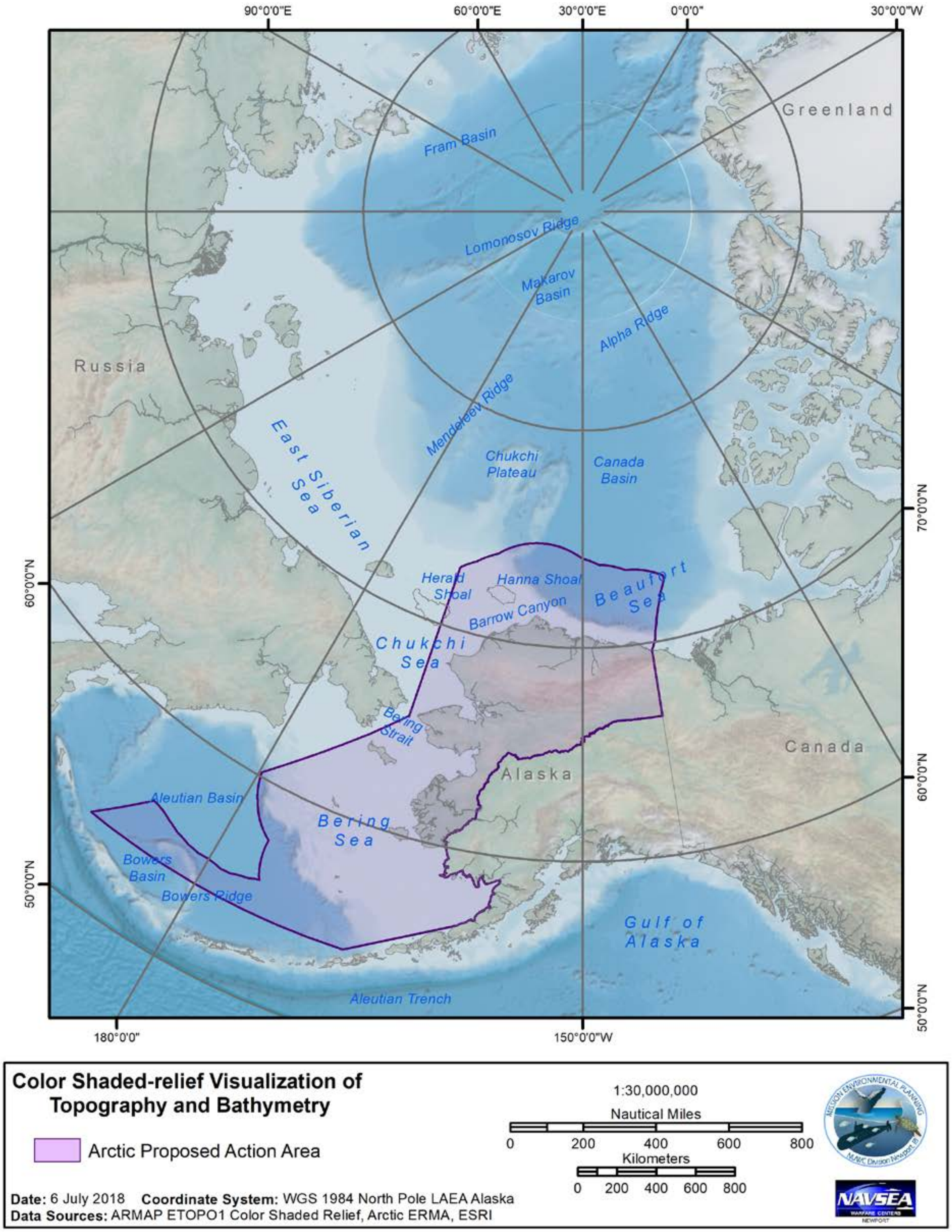


Figure 3-1. Visualization of the Bathymetric and Topographic Features of the Arctic Proposed Action Area

3.1.2 Sea Ice

Section 3.1.2.1 and Section 3.1.2.2 describe the Arctic and Antarctic proposed action areas in more detail. Below is a description of sea ice relative to the Arctic and Antarctic proposed action areas, respectively. There is no sea ice in the Pacific Northwest proposed action area and therefore, that area is omitted from this section.

3.1.2.1 Arctic Proposed Action Area

Sea ice forms and melts with polar seasons, and affects both human activity and biological habitat (Richter-Menge and Overland 2010). Sea ice directly impacts coastal areas and broadly affects surface reflectivity, ocean currents, water clarity, humidity, and the exchange of heat and moisture at the ocean's surface. Since sea ice reflects the sun's heat, when ice retreat is greater and there is more open ocean, more of the sun's heat is absorbed, increasing the warming of the water (Karl et al. 2007). Arctic sea ice, the frozen seawater that floats on the surface of the ocean and covers millions of square kilometers, plays a crucial role in Northern Hemisphere climate and ocean circulation (NSIDC 2007; Serreze et al. 2003). Sea ice extent fluctuates annually and is influenced by natural variations in atmospheric pressure and wind patterns. However, clear linkages have also been made to decreased Arctic sea ice extent and rising greenhouse gas concentrations dating back to the early 1990s (Karl et al. 2007).

The marine, terrestrial, and freshwater ecosystems of the Arctic, in particular in the Bering-Chukchi-Beaufort Region, are in transitional states in large part driven by warming temperatures. Arctic temperatures are rising faster than the global average. The Earth's climate has warmed approximately 1.1 degrees Fahrenheit (°F; 0.6 degrees Celsius [°C]) over the past 100 years with 2 main periods of warming occurring between 1910 and 1945 and from 1976 to present day (Walther et al. 2002). Temperature trends in the Arctic exhibit regional and annual variability (Maxwell 1997; Symon et al. 2005); however, a general warming trend has been observed since the late 1970s. The Arctic was warmer from 2011 to 2015 than any time since instrumental records began in 1900, and has been warming more than twice as rapidly as the rest of the world as a whole for the past 50 years (AMAP 2017).

Warming air temperatures have played a major role in the observed increase in permafrost temperatures around the Arctic rim, earlier spring snowmelt, reduced sea ice, widespread glacial retreat, increases in river discharge into the Arctic Ocean, and an increase in greenness of Arctic vegetation (Richter-Menge and Overland 2010). The heating effect from greenhouse gases is considered the probable cause of the global warming observed over the last 50 years. The potential impact or harm of greenhouse gas emissions are by nature global, and may result in cumulative impacts because individual sources of greenhouse gas emissions are not large enough to have any noticeable effect on climate change.

The primary terrestrial environment of the Bering-Chukchi-Beaufort Region is one of permafrost and tundra, with low-lying coasts that are vulnerable to erosion and storm surge inundation. The tundra ecosystems have evolved in response to low temperatures, little precipitation, nutrient limitations, short growing and reproductive seasons, and widespread permafrost. The rapid loss of sea ice causes large temperature changes inland, which can in turn trigger permafrost degradation or subject permafrost to rapid decomposition in the future. Reduced sea ice also increases coastal erosion and flooding associated with coastal storms. Runoff and storms may alter the timing and location of plankton blooms, which can lead certain marine species, such as fish, to experience biological shifts (Karl et al. 2007).

Sea ice reduction may also provide opportunities for increased shipping and transportation as well as increased resource extraction, including an occurrence of these activities where there has not previously been access (Karl et al. 2007). In September of 2007, the sea ice recession was so vast that the Northwest Passage completely opened up for the first time in human memory (NSIDC 2007) and the Arctic Ocean could be largely free of sea ice as early as summer of 2030 (AMAP 2017).

A general downward trend in Arctic sea ice has occurred during the last few decades (Serreze et al. 2003). The ice is declining faster than computer models had projected, and this downward trend is predicted to continue (Karl et al. 2007; NSIDC 2007; Timmermans et al. 2014). The decrease in sea ice extent during the month of January from 1979 to 2017 is estimated at approximately a 3.2 percent decrease in sea ice per decade (National Snow and Ice Data Center 2017b). Sea ice thickness in the central Arctic Ocean declined by 65 percent over the period from 1975–2012 (AMAP 2017). Annually, sea ice extent is at its maximum in March, representing the end of winter, and is at its minimum in September (Richter-Menge and Overland 2010). Data from 2016 reveal a September minimum extent of 1.60 million mi^2 (4.14 million km^2). September 2012 remains the record low minimum ice extent of 1.32 million mi^2 (3.41 million km^2) (National Snow and Ice Data Center 2017b). All of the ten lowest minimums have occurred in the last decade (National Snow and Ice Data Center 2017b). The maximum ice extent from March 2017 continued its third straight year as the new lowest maximum ice extent in the 37-year satellite record. The March 2017 maximum extent (Figure 3-2) measured 5.57 million mi^2 (14.42 million km^2) (National Snow and Ice Data Center 2017b).

The age of the sea ice is another key descriptor of the state of the sea ice cover. Older ice (4 years or older) that has survived multiple summers is rapidly disappearing; beginning in March 2014, most sea ice in the Arctic was "first year" ice. First year ice grows in the autumn and winter but melts during the spring and summer and is also the thinnest type of ice. In 2014, first-year ice comprised 69 percent of the ice extent. In 1988, 26 percent of ice cover was the oldest ice. In 2016, the oldest ice only constituted 1.2 percent of the pack (Perovich et al. 2016). Sea ice has also been freezing later and melting earlier than usual over the past few years, leading to a decline in multi-year ice (Overland and Wang 2013; Overland et al. 2010).

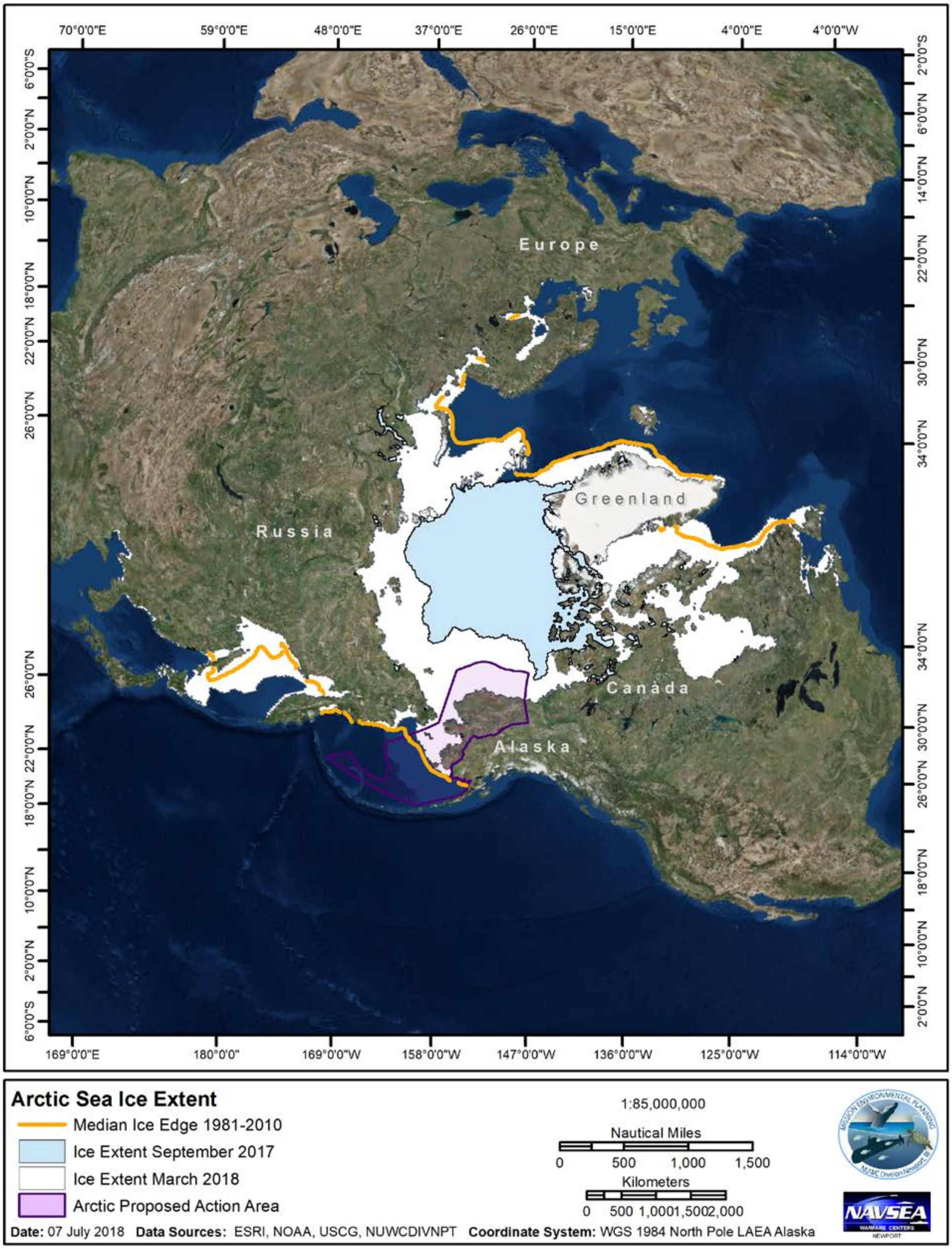


Figure 3-2. The Maximum Sea Ice Extent Reached in March 2018 as Compared to the Ice Extent from September 2017

3.1.2.2 Antarctic Proposed Action Area

Sea ice extent, the distance between the coast and the edge of the ice pack, fluctuates annually and is influenced by air and water temperature changes, wind patterns, and climate (Ainley et al. 2010b). Data taken continuously since 1978 reveal that Antarctic sea ice extent ranges from an average minimum extent of 1.2 million mi^2 (3.1 million km^2) in February to an average maximum of 7.1 million mi^2 (18.5 million km^2) in September. Despite the significant sea ice loss in the Arctic and negative global trend in sea ice, the net Antarctic sea ice growth has been almost zero, but increasing (Parkinson 2014). However, these sea ice changes are highly localized between regions. For instance, the Western Antarctic Peninsula sea ice extent has decreased by 40 percent over a 30-year period, largely due to warmer air temperatures having risen above freezing for the majority of the year (Antarctic and Southern Ocean Commission (ASOC) 2008). The Ross Sea has contributed the most to Antarctica's positive trend, with the ice increasing 5,290 mi^2 (13,700 ± 1,500 km^2) per year (Parkinson and Cavalieri 2012). (Ainley et al. 2010b) suggest that stronger winds over the Amundsen Sea have strengthened the Ross Sea's sources of cold, high-salinity shelf water thus increasing circulation and ice production. In 2017, the Antarctic wintertime sea ice extent reached a record low, and it is unknown whether it was a result of usual year-to-year variability, or if it has marked a downward shift in the trend of Antarctic ice increase (Vinas 2017).

3.1.3 Sound

Each of the proposed action areas includes different combinations of mediums through which sound interacts: sound in air, in water, and under ice. Biological and manmade (anthropogenic) sounds make up the existing soundscape environments. In-air noise decreases with distance, with a decrease in sound level from any single noise source following the "inverse-square law." Therefore, aircraft sound levels actually at the air-water interface (i.e., sea surface) is a function of how high above the surface the aircraft is flying or hovering. The higher the aircraft, the less sound reaches the sea surface (Eller and Cavanagh 2000; Richardson et al. 1995). Sound is transmitted from an airborne source to a receptor underwater, such as a marine mammal by: (1) direct path, refracted upon passing through the air-water interface; and, (2) direct-refracted paths reflected from the bottom in shallow water.

The in-water soundscape is made up of both anthropogenic and biological sounds. Anthropogenic sources of sound in the proposed action areas includes smaller vessels such as skiffs, larger vessels for pulling barges to deliver supplies to communities or industry work sites, icebreakers, and vessels for tourism and scientific research which all produce varying noise levels and frequency ranges. In the open ocean, ambient noise levels are between about 60 and 80 dB re 1 µPa, especially at lower frequencies (below 100 hertz [Hz]) (NRC 2003). Anthropogenic sources also include sources such as sonar and seismic surveying. In-water sound production modes used by marine mammals includes whistling, echolocation click production, calling, and singing. For instance, mysticetes typically emit signals with fundamental frequencies well below 1,000 Hz (Au et al. 2006; Cerchio et al. 2001; Munger et al. 2008); although, non-song humpback signals have peak power near 800 and 1,700 Hz (Stimpert 2010), and humpback song harmonics extend up to 24,000 Hz (Au et al. 2006).

Sound also travels under ice; ambient sound levels (of natural ice sounds) can vary greatly from season to season in a particular location due to environmental conditions (such as sea ice, temperature, wind, and snow) and the presence of marine life and anthropological sound. As observed by Ozanich et al. (2017), the median noise levels in the Eastern Arctic near the North Pole varied according to the dominant sources, including noise generated from ice, bowhead whale calls as far north as 86°24' N, seismic surveys farther southward, and earthquakes in the Arctic Basin. Dziak et al. (2015) recorded tens of “icequakes” per day in Antarctica with underwater sound levels ranging between 190–247 dB_{RMS} re 1 µPa @ 1 m.

3.2 Biological Environment

3.2.1 Marine Vegetation

The following provides an overview of the predominant benthic marine vegetation species and habitat types known to occur in the proposed action areas. Eight vegetation types are described: dinoflagellates, diatoms, blue-green algae, green algae, brown algae, red algae, haptophytes, and grasses. Major taxonomic groups potentially located within the proposed action areas are described in Table 3-1. No ESA-listed marine vegetation species are known to occur within any of the proposed action areas.

Table 3-1. Major Groups of Marine Vegetation Present in the Proposed Action Area

Taxonomic Group	Description	Vertical Distribution Within the Proposed Action Areas
Blue-green algae (Phylum Cyanobacteria)	Bacteria that are usually unicellular, but may appear in colonial arrangements; many form mats that attach to substrate and rocks. Some members of this group can produce nutrients for other marine species through nitrogen fixation.	Pelagic or benthic within the photic zone
Green algae (Phylum Chlorophyta)	Marine species can occur as unicellular algae, filaments, or large anchored or pelagic seaweeds.	Pelagic or benthic within the photic zone
Brown algae (Phylum Heterokontophyta)	Predominantly large multicellular seaweeds including kelp and rockweeds that often grow on the surface of rocks but are also epiphytic, endophytic, or pelagic.	Generally benthic occasionally pelagic within the photic zone
Diatoms (Phylum Heterokontophyta)	Solitary or chain forming single-celled phytoplankton group known for silica-based cell walls. Can form prolific ice or ice edge associated blooms.	Pelagic or benthic within the photic zone. Occasionally sympagic
Dinoflagellates (Phylum Dinoflagellata)	Group of semi-motile marine protists, many of which are both autotrophic and heterotrophic. Mostly free swimming but occasionally benthic or symbiotic with coral species. Some species can cause harmful algal blooms.	Mostly pelagic, occasionally benthic
Red algae (Phylum Rhodophyta)	Includes both single-celled algae and multi-celled large seaweeds; some species form calcareous deposits.	Pelagic or benthic within the photic zone
Haptophytes (Phylum Haptophyta)	Includes solitary and colonial marine phytoplankton, such as coccolithophores, and some flagellates that can cause harmful algal blooms (e.g., Prymnesiophytes)	Pelagic within the photic zone
Seagrass and cordgrass (Phylum Spermatophyta)	Flowering plants, which are adapted to salty marine environments in mudflats, marshes, intertidal and subtidal coastal waters, providing habitat and food for many marine species.	Seafloor

Factors that influence the distribution and abundance of marine vegetation include the availability of light and nutrients, water quality, water clarity, salinity level, seafloor type (important for rooted or attached vegetation), currents, tidal schedule, and temperature (Green and Short 2003). Marine ecosystems depend almost entirely on the energy produced by photosynthesis of marine plants and algae, which serve as the base of the food web (Castro and Huber 2000; Horner and Schrader 1982). In both surface waters and the photic zone (the portion of the water column illuminated by sunlight), marine algae and flowering plants provide oxygen, food, and in some cases, habitat for many organisms (Dawes 1998). In contrast to deep waters that are dominated by plankton, intertidal and shallow subtidal waters often have large populations of anchored or rooted vegetation such as rockweeds, kelp, or seagrass, which provide both habitat and food for many marine species.

3.2.1.1 Arctic Proposed Action Area Overview

Virtually all marine vegetation in the open ocean portions of the Arctic are phytoplankton, predominantly pelagic dinoflagellates and diatoms. Phytoplankton flourish in, under, and adjacent to thick layers of ice. They are about four times higher in abundance under the ice than in the open water, with ice algal production accounting for 3 to 25 percent of total system primary productivity, including more than half of primary productivity occurring in the high Arctic (Horner and Schrader 1982; Kohlbach et al. 2016). Dunton et al. (2005) collected chlorophyll-a concentrations during the ice-free period from late May to September between 1974 and 1995, noting levels between 10 and 15 milligrams per cubic meter (mg/m^3) within the Arctic proposed action area, which is high for this region. The Bering Sea is also critically dependent on the timing and magnitude of phytoplankton blooms, but generally experiences a spring and fall bloom cycle, as opposed to a single summer bloom. During the blooms, chlorophyll-a concentration can average 15–25 mg/m^3, with instantaneous concentrations as high as 60 mg/m^3. These blooms are typically comprised primarily of diatoms, but dinoflagellate blooms can also occur (Mordy et al. 2017; Sigler et al. 2014).

Dinoflagellates are eukaryotic, single-celled, and predominantly marine plankton (Bisby et al. 2010). They occur throughout the proposed action area, and over 70 species have been identified in Arctic sea ice (Bluhm and Gradinger 2008). Organisms such as zooplankton feed on dinoflagellates. Dinoflagellates are responsible for some types of harmful algal blooms caused by sudden increases of nutrients (e.g., fertilizers) from land into the ocean or changes in temperature and sunlight (Levinton 2009). Common genera of dinoflagellates that occur in the proposed action area are *Ceratium* and *Noctiluca* (Marret and Zonneveld 2003). Most dinoflagellates are photosynthetic; however, many can ingest small food particles.

Diatoms are planktonic, single-celled organisms with cell walls made of silica (Castro and Huber 2000). Most species are found in the photic zone, the upper 656 ft (200 m) of the water column, and under ice in the open ocean areas of the proposed action area. Large diatom blooms within the proposed action area are critical for Arctic food webs, as they support subsequent zooplankton blooms, as well as exporting organic material to the benthos (Sigler et al. 2014). Arctic diatom blooms are typically dominated by species in the genera *Chaetoceros*, *Thalassiosira*, and *Fragilariopsis* (Arrigo et al. 2012; Kohlbach et al. 2016; Lovejoy et al. 2006).

Seagrasses are also an important contributor in the shallow coastal regions of the proposed action area. Eelgrass (*Zostra marina)* is found as far north as the Chukchi Sea, and is abundant in many coastal portions of the Bering Sea, particularly in Bristol Bay and the coastal portions of the Togiak Wildlife Refuge (Winfree 2005). Although the contribution of eelgrass to overall system productivity is low, predominantly because it is found only in shallow (<30 ft [10 m]) subtidal habitats, seagrasses provide critical nearshore nursery habitat for many species of fish and invertebrates, including herring, which is a major regional fishery. Consequently, this habitat also provides important feeding grounds and migratory stopover habitat for many coastal and migratory bird species, including the black brandt (*Branta bernicula nigricans)* and the ESA-listed Steller's eider (*Polysticta stelleri)* (Winfree 2005).

3.2.1.2 Antarctic Proposed Action Area Overview

Virtually all of the marine vegetation in the Antarctic proposed action area is phytoplankton. The Ross Sea is one of the most prolific Antarctic marine habitats with respect to phytoplankton productivity. Chlorophyll concentrations frequently exceed 15 mg/m^3 during blooms. Annual net primary productivity in the Ross Sea is highly variable from year to year, but is on the order of 100–300 grams of carbon per square meter per year ($gC/m^2/y$), though daily productivity may be as high as 2–3 grams of carbon per square meter per day ($gC/m^2/day$) during blooms (Schine et al. 2016; Smith et al. 2014). Factors influencing inter-annual variability in plankton abundance include the El Niño Southern Oscillation and the Southern Annular Mode (Schine et al. 2016).

Blooms are highly seasonal, dominated by the haptophyte *Phaeocystis antarctica* in spring and by a diverse assemblage of diatoms throughout the austral summer (Rozema et al. 2017). The dominance of *P. antarctica* in this system can be explained by its ability to outcompete larger diatoms for the limited amount of solar radiation available in the photic zone during the austral springtime. During this time, mixed layer depths can be as deep as 164 ft (50 m). In contrast, during the austral summer, when irradiance is higher, the mixed layer can be as shallow as 33 ft (10 m), which means much more light is available and diatoms flourish. The limiting input becomes iron rather than nitrate or sunlight (Smith et al. 2014).

3.2.1.3 Pacific Northwest Proposed Action Area Overview

Marine vegetation along the West Coast of the United States is represented by more than 700 varieties of seaweeds, seagrasses (Leet et al. 2001; Wyllie-Echeverria and Ackerman 2003), and canopy-forming kelp species (Wilson 2014). Extensive mats of red algae provide habitat in areas of exposed sediment along the coast (Adams et al. 2004). Areas within the influence of the California Current are considered moderately productive with a primary productivity range of 150—300 $gC/m^2/y$ (Hogan 2011). The phytoplankton community is seasonally and annually variable, dominated by chain forming diatoms such as *Skeletonema, Thalassiosira,* and *Chaetocerous,* with occasionally large blooms of centric diatoms (e.g., *Coscinodiscus)* and dinoflagellates (Hannach and Swanson 2017). Primary productivity in inshore communities is driven by a typical fall and winter/spring bloom frequency, while from March to July, upwelling along the coast increases primary productivity. Fluctuations in the year-to-year productivity of the ecosystem can be substantial, and are the result of the El Niño Southern Oscillation, Pacific Decadal Oscillation, and other changes in the rates of coastal upwelling.

Many listed species and species of concern in the nearby Puget Sound/Salish Sea ecosystem are critically dependent on seagrass and macroalgae communities at various life stages. These ecosystems are facing high levels of anthropogenic threats; however, seagrasses and rooted macrophytes (kelp) have more limited coastal and shallow water distributions that are somewhat removed from the proposed action area (Zier and Gaydos 2016). The relative distribution of seagrass is influenced by the availability of suitable substrate in low to moderate wave-energy areas at depths that allow sufficient light exposure.

3.2.2 Invertebrates

Marine invertebrates are a large, diverse group containing tens of thousands of species distributed ubiquitously throughout the global marine environment (Brusca and Brusca 2003). Within the proposed action areas, marine invertebrates inhabit both coastal and offshore waters and occupy pelagic, demersal, epibenthic, and benthic habitats, though the greatest densities of marine invertebrates are typically found in and on the seafloor (Sanders 1968). Sea ice provides a habitat for algae and a nursery ground for invertebrates during times when the water column does not support phytoplankton growth (Michel et al. 2002). Referred to as the sympagic zone, invertebrates live within the pores and brine channels of the ice (small spaces within the sea ice which are filled with a salty solution, called brine) or at the ice-water interface. Biodiversity of species is low within the sympagic zone due to the extreme conditions (Nuttall 2005). Pelagic habitats include coastal, open ocean, and frontal zones, as well as upwelling and downwelling areas. Within the pelagic zone, plankton are highly stratified by depth, with most of the biomass in the upper portions of the water column. The benthic zone is the most diverse and species-rich habitat, where the majority of the species within the ocean can be found. In polar environments, many sympagic species also exist in and along the edges of ice coverage, feeding on blooms of phytoplankton and other algae which grow in, on, or adjacent to the ice (Kohlbach et al. 2016).

Major taxonomic groups potentially located within the proposed action areas and the distinct water body zones (benthic, pelagic, or sympagic zone) they inhabit are described in Table 3-2. The following discussion provides an overview of the predominant marine invertebrate species known to occur in the proposed action areas and general information on invertebrate hearing (see Section 3.2.2.4).

Table 3-2. Major Invertebrate Groups Found and the Expected Zones Inhabited within the Proposed Action Areas

Major Invertebrate Groups		Proposed Action Area		
Common Name (Phylum)	**Description**	**Antarctic**	**Arctic**	**Pacific Northwest**
Foraminifera, radiolarians, ciliates (Phylum Foraminifera)	Benthic and pelagic single-celled organisms that can be planktonic or benthic infaunal (live in the sediment). Shells are typically made of calcium carbonate or silica.	Pelagic Benthic	Pelagic Benthic	Pelagic Benthic
Sponges (Phylum Porifera)	Sessile epibenthic filter feeders; large species have calcium carbonate or silica structures embedded in cells to provide structural support.	Benthic	Benthic	Benthic
Corals, hydroids, jellyfish (Phylum Cnidaria)	Motile and sessile benthic and pelagic animals with stinging cells that can be solitary or colonial. Some form hard calcium carbonate exoskeletons. May form feeding aggregations along or under ice.	Pelagic Benthic Sympagic	Pelagic Benthic Sympagic	Pelagic Benthic
Flatworms (Phylum Platyhelminthes)	Mostly benthic infaunal species; simplest form of marine worm with a flattened body.	Pelagic Benthic	Pelagic Benthic	Pelagic Benthic
Ribbon worms (Phylum Nemertea)	Mostly benthic infaunal marine worms with a long extension from the mouth (proboscis) that helps capture food.	Benthic	Benthic	Benthic
Round worms (Phylum Nematoda)	Small marine worms; many live in close association with other animals (typically as parasites).	Pelagic Benthic	Pelagic Benthic	Pelagic Benthic
Segmented worms (Phylum Annelida)	Mostly infaunal, highly mobile marine worms; many tube-dwelling species.	Benthic	Benthic	Benthic
Bryozoans (Phylum Bryozoa)	Lace-like animals that exist as filter feeding colonies attached to the seafloor and other substrates.	Benthic	Benthic	Benthic
Cephalopods, bivalves, sea snails, chitons (Phylum Molluska)	A diverse group of soft-bodied invertebrates with a specialized layer of tissue called a mantle. Mollusks such as squid are active swimmers and predators, while others, such as sea snails, are mobile predators or grazers, or sessile filter feeders (e.g., bivalves).	Pelagic Benthic	Pelagic Benthic	Pelagic Benthic
Common Name (Phylum)	**Description**	**Antarctic**	**Arctic**	**Pacific Northwest**
Shrimp, crab, lobster, barnacles, copepods (Phylum Arthropoda –Crustacea)	A diverse group of invertebrates distinguished by a jointed exoskeleton. Some are sessile, but most are motile; all feeding modes from predator to filter feeder. Many copepods can form dense aggregations on, in, and adjacent to sea ice.	Pelagic Benthic Sympagic	Pelagic Benthic Sympagic	Pelagic Benthic
Sea stars, sea urchins, sea cucumbers (Phylum Echinodermata)	Epibenthic predators and filter feeders with tube feet.	Benthic	Benthic	Benthic

3.2.2.1 Arctic Proposed Action Area Overview

Marine invertebrates occur in all waters of the Arctic proposed action area, and are the dominant animals in all habitats of the proposed action area. Excluding microbes, approximately 5,000 known marine invertebrates have been documented in the Arctic; the number of species is likely higher, though, since this area is not well sampled (Josefson et al. 2013). The cold water of the Arctic generally results in slow growth and high longevity among invertebrates and food sources, which are only seasonally abundant. Major taxonomic groups found within the Arctic proposed action area are listed and described in Table 3-2. No endangered, threatened, candidate, or proposed species for listing under the ESA exists within the Arctic proposed action area. Essential Fish Habitat (EFH) has been designated for eight federally managed invertebrate species within the Arctic proposed action area (see Section 3.2.4.1). Because of the large number of species, a general discussion of each ecological zone (sympagic, pelagic, and benthic) is provided below.

3.2.2.1.a Benthic

The benthic zone is the most diverse and species-rich habitat, where the majority of the species within the Arctic proposed action area can be found. One study of Alaskan benthic community zonation in the coastal zone identified 339 invertebrates, including mollusks, polychaetes, and echinoderms, as well as less numerous crustaceans, worms, sponges, bryozoans, ascidians, and unidentified invertebrates (Konar et al. 2009). Benthic marine invertebrates play an important role in the food web as scavengers, recyclers of nutrients, habitat-forming organisms, or as prey to fish and whales.

Within the Arctic region, major species groups within the benthic zone that have the highest diversity and abundance are Arthropoda (e.g., crabs and barnacles), Bryozoa (moss animals), Mollusca (e.g., snails and clams), and Nematoda (Josefson et al. 2013). In a Beaufort Sea bottom trawl, the invertebrates with the highest densities in descending order of abundance were the notched brittle star (*Ophiura sarsi*), snow crab (*Chionoecetes opilio*), mussel (*Musculus* spp.), and the mud star (*Ctenodiscus crispatus*). Within the sediment, roundworms are one of the most widespread marine invertebrates with population densities of one million organisms per 11 square feet (ft^2; 1 square meter [m^2]) of mud (Levinton 2009). The principal habitat-forming invertebrates of the benthos are Porifera (e.g., sponges), Annelida (e.g., tubeworms), and Mollusca (e.g., oysters). On the inshore shelf of the Eastern Bering Sea, the sea star *Asterias amurensis* dominates, while offshore areas of the Bering Sea are most populated with Gastropods, Pagurid hermit crabs, and snow crab (Yeung and McConnaughey 2006).

Although there are over 100 documented coral species in the waters of Alaska, less than two dozen have been documented in the proposed action area. Within the proposed action area, the Bering Sea has the highest diversity, including soft corals, gorgonians, stylasterids and one species each of stony, black, and bamboo corals. In the Bering Sea, corals have predominantly been documented along the broad shallow continental shelf. *Eunepthea sp.* is the only species that has been reported north of the Bering Sea (Stone and Shotwell 2007). The vast majority of corals found in Alaska, and particularly within the proposed action area, are soft coral species. Soft corals are flexible, have calcareous particles in their body walls for structural support, can be found in both tropical and cold ocean waters, and do not grow in colonies or build reefs, although they can grow quite large and provide substantial structure and habitat (Stone and Shotwell 2007).

3.2.2.1.b Pelagic

In a zooplankton survey from the Arctic Canadian Basin within the pelagic zone, 50 percent of the biomass was concentrated in the upper layer from the surface to 328 ft (100 m) in depth (Hopcroft et al. 2008; Kosobokova and Hopcroft 2010; MacDonald et al. 2010). Specifically, zooplankton abundance and biomass decreased below 164 ft (50 m), followed by a slight increase from 656 to 984 ft (200 to 300 m), and a slow decrease below 984 ft (300 m). The increase at 656 ft (200 m) is thought to be attributed to the transition between the Pacific halocline and Atlantic waters (Kosobokova and Hopcroft 2010). In contrast, zooplankton biodiversity increases with increasing depth (MacDonald et al. 2010). However, the vast majority of the Bering sea region is shallow (<590 ft [180m]) and relatively well mixed, and the zooplankton composition is driven more by upwelling dynamics across the shelf break—a zone of rapid depth transition often referred to as the "green belt" due to the high productivity (Eisner et al. 2014; Guy et al. 2014).

Taxonomic groups observed in the proposed action area have been listed in Table 3-2 (Eisner et al. 2014; Kosobokova and Hopcroft 2010). The 111 species identified by Kosobokova and Hopcroft (2010) included 74 crustaceans (copepods, euphausiids, amphipods, decapods, and ostracods), 17 cnidarians (hydromedusae, scyphomedusae, siphonophora), one foraminiferan, four ctenophores, two pteropods, four larvaceans, four chaetognaths, and five polychaetes (Kosobokova and Hopcroft 2010). However, the pelagic zone invertebrate fauna is numerically dominated by large copepods such as *Calanus glacialis* and *C. hyperboreus,* which constitute as much as 91 percent of the observed abundance in the Beaufort Sea (MacDonald et al. 2010), and are among the dominant species in the Bering Sea (Eisner et al. 2014; Guy et al. 2014). Copepods in the Arctic have longer life cycles (two to four years) and are larger than copepod species living in warmer water (Hopcroft et al. 2008). Sirenko (2001) and Sirenko et al. (2010) found that cnidarians are second to copepods in diversity and numbers. Gelatinous zooplankton (e.g. ctenophores, jellyfish and salps) are important invertebrate predators throughout the proposed action area (Guy et al. 2014; Josefson et al. 2013). Based on previous studies (e.g. Harding 1966; Virketis 1957), the overall species assemblages in this region have not changed significantly in the past 50 to 60 years (Kosobokova and Hopcroft 2010).

The continental shelf of the northern Bering Sea and southern Chukchi Sea is highly productive, from primary producers to sea birds and marine mammals. Waters in this region are shallow but receive an advection of oceanic water from the Bering Sea basin to the southwest. The large copepods, *Neocalanus cristatus* and *N. plumchrus,* as well as *Thysanoessa* spp. euphausiids, dominate this Bering Strait region (Bedard 1969; Springer and Roseneau 1985). In the southeastern Bering Sea, these species are joined by *Eucalanus bungii* and *Metridia pacifica* in controlling the spring diatom bloom (Cooney 1981; Smith et al. 1986). In Bering Shelf Water and coastal Alaskan water, *Calanus marshallae* dominate.

3.2.2.1.c Sympagic

Species abundance within the ice is highly variable with most species occurring within the 4 inches (in; 10 centimeters [cm]) of ice closest to the ice/water interface. In the Arctic, the most dominant sympagic species are nematodes, harpacticoid copepods, and rotifers (Josefson et al. 2013). At the ice-water interface, *Apherusa glacialis, Onisimus glacialis, O. nanseni,* and *Gammarus wilkitzkii* are common amphipods (Gradinger et al. 2010). Although the sympagic environment is spatially limited, recent research indicates that large pelagic copepod species such as *Calanus glacialis* and *C. hyperboreus*, which are a primary food source for higher trophic levels, are substantially dependent on sea ice synthesized carbon, illustrating the importance of this unique environment to the broader Arctic food web (Kohlbach et al. 2016).

3.2.2.2 Antarctic Proposed Action Area Overview

Marine invertebrates occur in all waters of the proposed action area and are a critical link in the food web, which supports large populations of penguins, pinnipeds, and cetaceans. The cold water of the Antarctic generally results in slow growth and high longevity among invertebrates and food sources that follow a strong seasonal cycle driven by ice cover and iron availability supporting phytoplankton growth (Rozema et al. 2017; Schine et al. 2016). Similar to the Arctic, the benthos is host to the highest abundance and diversity of marine invertebrate organisms, with over 4,100 benthic species documented; the most abundant species are polychaetes, gastropods, and amphipods (Clarke and Johnston 2003). Major taxonomic groups found within the Antarctic proposed action area are listed and described in Table 3-2.

No endangered, threatened, candidate, or proposed species for listing under the ESA exist within the Antarctic proposed action area. Additionally, EFH has not been designated for any federally managed invertebrate species within the Antarctic proposed action area. Because of the large number of species, a general discussion of each ecologic zone (sympagic, pelagic, and benthic) is provided below.

3.2.2.2.a Benthic

The benthic environment of the Antarctic proposed action area is home to the largest abundance and diversity of marine invertebrates, with over 4,100 documented species (Clarke and Johnston 2003) despite relatively poor sampling coverage. Some estimates place the total number of likely species as high as 17,000 (Clarke 2008). This diversity is due in large part to the varied habitats determined by depth, food supply, and current regime (Smith et al. 2014). Organisms living in the benthic Antarctic environment are not without a unique set of challenges. The continental shelves of the Southern Ocean are much deeper than those of other landmasses, extending down to approximately the 3,281 ft (1,000 m) isobath, and many areas are covered with seasonal or permanent ice, further reducing available light at depth. While ice edge areas and regions under thinner ice may bloom with phytoplankton, there is little or no surface phytoplankton production under thick permanent ice. Since detrital food sources, like those resulting from phytoplankton blooms, are critically important in typical benthic food webs, areas under thick, permanent ice are generally thought to be marine deserts (Clarke and Johnston 2003). Similar to Arctic communities, the benthic community of the Antarctic is typified by slow growing, long-lived organisms with a very high number of species unique to that region (Smith et al. 2014). The most commonly observed taxa are polychaetes, gastropods, and amphipods, though pycnogonids and echinoderms are also abundant (Clarke 2008). One striking absence from the benthic community are the decapods, with only a dozen or so observed species. Brachyuran crabs and lobsters are now completely absent from the Southern Ocean, though there is evidence in the fossil record of their previous presence (Clarke and Johnston 2003).

3.2.2.2.b Pelagic

The zooplankton of the Antarctic proposed action area support one of the most abundant and diverse arrays of pelagic predators, including squid and fish, but also large populations of penguins and whales (Schine et al. 2016; Smith et al. 2014). *Calanoides acutus, Metridia gerlachei*, and *Euchaeta antarctica* are the dominant observed copepod species. Antarctic krill (*Euphausia superba*) are abundant along the shelf break, while crystal krill (*Euphausia crystallorophias*) dominate the inner shelf region of the Ross Sea (Sala et al. 2002). Although the regional primary productivity rates are high, the overall zooplankton biomass in the Ross Sea is only about 15 percent of that observed in comparable Arctic ecosystems. From this comparison, it is thought that top down control by apex predators (e.g., penguins and whales) plays an important role in driving zooplankton biomass in the Antarctic (Smith et al. 2014).

3.2.2.2.c Sympagic

In general, the Antarctic sympagic community is composed of algae growing in and on the ice, as well as a range of autotrophic and heterotrophic bacteria, and larger heterotrophic animals which graze on the aforementioned primary producers (Pinkerton et al. 2010). Antarctic sympagic invertebrates are patchy, but can be very abundant. Densities can be as high as 90 milligrams per square meter (mg/m^2), with higher abundance and diversity in regions with perennial ice cover than in areas with only seasonal cover (Kramer et al. 2011). In general, sea ice appears to have a strong relationship with overall chlorophyll levels. In summers following winters of low sea ice cover, there is generally decreased stratification and lower chlorophyll levels. While the general trend of sea ice coverage in Antarctica is decreasing, the Ross Sea ice shelf has been increasing in size (Stammerjohn et al. 2008). Although sea ice dynamics play a critical role in the ecology of the Ross Sea, sea ice productivity accounts for only a small fraction of the overall system production, an estimated 3.5 percent (Pinkerton et al. 2010). This is in contrast to the larger role which sea ice productivity plays in the Arctic food web (Kohlbach et al. 2016).

3.2.2.3 Pacific Northwest Proposed Action Area Overview

The Pacific Northwest proposed action area lies at the intersection of the California Current and Gulf of Alaska Large Marine Ecosystem units. The deeper waters of the proposed action area are somewhat removed from the nearby coastal regions of Puget Sound and the Juan de Fuca submarine canyon system. However, the proposed action area is still within the continental slope region and abuts the Olympic Coast National Marine Sanctuary. High productivity from coastal sources, upwelling, and chemosynthetic vent communities (e.g. Van Ark et al. 2007) contributes to abundant and diverse planktonic and benthic communities in the proposed action area. Major taxonomic groups found within the Pacific Northwest proposed action area are listed and described in Table 3-2. No endangered, threatened, candidate, or proposed species for listing under the ESA, exists within the Pacific Northwest proposed action area. The proposed action area is within the geographic range of the pinto abalone (*Haliotis kamtschatkana),* which is a federally listed species of concern; however, the maximum depth for the pinto abalone is considered to be approximately 328 ft (100 m) (National Marine Fisheries Service 2017e), which is substantially shallower than the waters of the Pacific Northwest proposed action area. Therefore, it is not expected that this species would be encountered during the Proposed Action. Additionally, EFH has not been designated for any federally managed invertebrate species within the proposed action area. Due to the large number of species, a general discussion of each ecologic zone (sympagic, pelagic, and benthic) is provided below.

3.2.2.3.a Benthic

Marine benthic invertebrates are abundant across the varied bottom habitats of the Pacific Northwest proposed action area, which is predominantly abyssal plain but also includes areas of continental slope and submarine canyon environment. The biological diversity of these communities is high and includes sponges, polychaetes, crustaceans, mollusks, echinoderms, and bryozoans (Freiwald et al. 2004; Roberts and Hirshfield 2003). Similar to the cold water species encountered in the Arctic and Antarctic proposed action areas, deep benthic animals grow more slowly, live longer, and have smaller broods than animals living in shallow waters (Airame et al. 2003). In many areas of the abyssal plain, brittle stars are so abundant that their feeding behavior and high activity levels alter the ecology of benthic, soft bottom communities (Airame et al. 2003).

Deep-sea coral communities are found along the entire continental slope of the proposed action area. Black corals are the most common on the continental slope, while the rare *Lophelia sp*. is found off the Washington coast. Recent studies indicated that deep corals are widespread on seamounts and continental shelves throughout the Northeast Pacific, occurring down to a depth of 15,500 ft (4,700 m) (Etnoyer and Morgan 2005; Morgan et al. 2005).

In most marine ecosystems, the primary producers at the base of the food chain include phytoplankton, macroalgae, and seagrasses that produce energy through photosynthesis. However, in environments on the ocean floor rich in methane and sulfides, such as the Juan de Fuca Ridge within the northwest corner of the Pacific Northwest proposed action area, chemosynthetic bacteria use sulfur-oxidizing, methane-oxidizing, and sulfide-reducing processes to create energy and organic matter that can be used by other organisms in the environment. Common animals in these types of ecosystems include tubeworms, giant white clams, mussels, gastropods, and sponges (Kojima 2002). Chemosynthetic communities are a significant source of biological productivity on the deep-sea floor, and some such communities occur in association with fields of hydrothermal vents. These can occur in the tectonically active portions of the proposed action area, or near whale falls or gas hydrates in the sediments often found on continental slopes (Lumsden et al. 2007; Smith et al. 2003).

3.2.2.3.b Pelagic

The zooplankton community in the Pacific Northwest proposed action area is highly diverse, ranging in size from jellyfish-like *Pelagia* spp., which can exceed 6 ft (1.8 m) in length, to microscopic rotifers and heterotrophic protozoans (Perry 2003). Many members of this community, such as copepods, euphausiids, and cladocerans, are holoplanktonic, meaning they spend their entire lives as members of the planktonic community. Holoplankton serve as an important linkage between phytoplankton primary producers and the rest of the food web, both by serving as a major prey item for fish and whales and by recycling and exporting organic matter to the benthos through excretion and mortality. Zooplankton inhabits all depths and often undertakes daily vertical migrations of up to several hundred feet in distance travelled. Dominant euphausiid species, which are key prey species for whales, include multiple genus of krill—predominantly *Thysanoessa spp.* and North Pacific krill (*Euphausia pacifica*) (Gómez-Gutiérrez et al. 2005; Linacre 2004). However, much of the zooplankton biomass is made up of meroplanktonic organisms, which are dependent on planktonic larval stages for dispersal and growth, but eventually become either benthic or free swimming pelagic organisms. Most fish and many demersal invertebrates such as crabs, bivalves, and polychaetes are meroplanktonic. In addition to serving as an important food source during their larval stages, the survival rates through these early planktonic stages are a key indicator of recruitment success for many of these species (Perry 2003). In general, copepods are the dominant group of zooplankton in terms of biomass in the proposed action area (Landry and Lorenzen 1989). The copepod community varies seasonally and is dominated by boreal species such as *Pseudocalanus minimus, Calanus marshallae* and *Acartia longiremis* in the summer. In the winter, a more diverse group of temperate calanoid copepods, including *Paracalanus parvus, Cetoncalanus vanus, Calanus pacificus*, and *Mesocalanus tenuicornis,* makes up the majority of the biomass (Peterson and Keister 2003). Salps are more abundant in phytoplankton-rich surface waters but have been found at depths down to 3,300 ft (1,000 m) (Hubbard Jr and Pearcy 1971). Many of these soft-bodied invertebrates are important sources of food for sea turtles.

3.2.2.4 Invertebrate Hearing

Hearing capabilities of invertebrates are poorly understood (Lovell et al. 2005; Popper and Schilt 2008). While data are limited, research suggests that some of the major decapods and cephalopods may have limited hearing capabilities (Edmonds et al. 2016; Hanlon 1987; Offutt 1970), particularly of low frequency sound. In a review of crustacean sensitivity of high amplitude underwater noise by Edmonds et al. (2016), it was found that crustaceans may be able to hear the frequencies at which they produce sound, but it remains unclear which noises are incidentally produced and if there are any negative effects from masking them. Acoustic signals produced by crustaceans range from low frequency rumbles (20–60 Hz) to high frequency signals (20–55 kHz) (Henninger and Watson 2005; Patek and Caldwell 2006; Staaterman 2016). Decapod crustaceans respond primarily to sounds well below 1 kHz (Celi et al. 2014; Edmonds et al. 2016). Both behavioral and auditory brainstem response studies suggest that crustaceans may sense frequencies up to 3 kHz, but best sensitivity is likely below 200 Hz (Goodall et al. 1990; Lovell et al. 2005; Lovell et al. 2006). Most cephalopods likely sense low-frequency sound below 1,000 Hz, with best sensitivities at lower frequencies (Budelmann 2010; Mooney et al. 2010; Offutt 1970). A few cephalopods may sense frequencies up to 1,500 Hz (Hu et al. 2009).

Aquatic invertebrates that can sense local water movements with ciliated cells include cnidarians, flatworms, segmented worms, urochordates (tunicates), mollusks, and arthropods (Budelmann 1992a, 1992b; Popper et al. 2001). Some aquatic invertebrates have specialized organs called statocysts for determination of equilibrium and, in some cases, linear or angular acceleration. Statocysts allow an animal to sense movement and may enable some species, such as cephalopods and crustaceans, to be sensitive to water particle movements associated with sound (Hu et al. 2009; Kaifu et al. 2008; Montgomery et al. 2006; Popper et al. 2001). Because the sensory capabilities associated with statocysts are limited to detecting water motion, and water particle motion near a sound source falls off rapidly with distance, aquatic invertebrates are most likely limited to detecting nearby sound sources rather than sound caused by pressure waves from distant sources.

Studies of sound energy effects on invertebrates are few and identify only behavioral responses and some sub-lethal non-auditory responses (Celi et al. 2014; Edmonds et al. 2016; Roberts and Breithaupt 2016). Permanent threshold shift (PTS), temporary threshold shift (TTS), and masking studies have not been conducted for invertebrates.

3.2.3 Fish

Marine fish can be broadly categorized by their horizontal and vertical distributions in the water column and habitat associations. The proposed action areas include a variety of marine habitats, including shallow coastal, deep-sea benthic and near-shore and open-ocean pelagic environments. As reviewed by Bluhm et al. (2011), habitat preference in bottom-oriented fishes is primarily driven by sediment type, bottom salinity, and bottom temperature, while water column temperature and salinity characterize ichthyoplankton and fish distribution patterns in shallower waters. Many temperate fishes are intolerant to the low temperatures of bottom waters in ice-covered regions. Therefore, sea ice extent, with its inter-annual and decadal scale variability, reasonably corresponds in spatial extent to the boundary between polar and subpolar demersal and benthic fish communities (Mecklenburg et al. 2011; Wyllie-Echeverria and Wooster 1998). In the Arctic, higher trophic level predators, such as ringed seals (*Phoca* *hispida*), prey on fish species that are closely associated with sea ice, such as Arctic cod (*Boreogadus saida*) and polar cod (*Arctogadus glacialis)* (Lønne and Gabrielsen 1992). In the Antarctic, top predators include elephant and leopard seals (*Mirounga leonine* and *Hydrurga leptonyx,* respectively), penguins, and several whale species (Pinkerton et al. 2010).

The following discussion includes major fish groups inhabiting the proposed action areas, listed below in Table 3-3. The species that are federally managed under the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) are listed in Table 3-5 and discussed in Section 3.2.4. The ESA-listed species within the proposed action areas are listed in Table 3-4. Of the major fish groups found in the proposed action areas, Arctic cod is the only species that has EFH (and is therefore a federally managed) associated with ice floes. Therefore, their role in the arctic sympagic habitat is discussed in more detail in Section 3.2.3.1.a. General information on fish hearing sensitivity is discussed in Section 3.2.3.5.

Table 3-3. Major Fish Groups Present in the Proposed Action Areas and Distribution within the Water Column

Order	Representative Species	Proposed Action Area			Distribution in the Water Column
		Arctic	Antarctic	Pacific Northwest	
Acipenseriformes	Sturgeon, paddlefish			x	demersal
Anguilliformes	True eels, morays	x	x	x	demersal/bathydemersal
Atheriniformes	Silversides			x	neritic-pelagic/reef associated
Aulopiformes	Lancefish, daggertooths, waryfishes		x	x	bathypelagic/oceanic-pelagic
Batrachoidiformes	Toadfish			x	demersal
Beloniformes	Flying			x	oceanic-pelagic
Beryciformes	Squirrelfish, common fangtooth	x		x	bathypelagic
Carcharhiniformes[1]	scalloped hammerhead			x	benthopelagic/oceanic-pelagic
Chimaeriformes[1]	Chimaeras, rat fish, ghost sharks			x	demersal/bathydemersal
Clupeiformes	Pacfic herring, American shad	x		x	neritic-pelagic
Gadiformes	Arctic cod, polar cod	x	x	x	demersal/benthopelagic
Gasterosteiformes	Stickleback, pipefish	x		x	benthopelagic
Hexanchiformes[1]	Cow sharks	x		x	bathydemersal
Lamniformes[1]	mackeral sharks	x		x	oceanic-pelagic
Lampriformes	King-of-herring, opah	x	x	x	oceanic-pelagic/bathypelagic
Lophiiformes	Goosefish, frogfish, batfish	x	x	x	bathypelagic
Mugiliformes	Mullets			x	benthopelagic
Myctophiformes	Glacier laternfish	x	x	x	bathypelagic/oceanic-pelagic
Myliobatiformes[1]	Stingrays			x	demersal/pelagic-oceanic
Myxiniformes	Hagfish	x	x	x	demersal/bathydemersal
Notacanthiformes	Halosaurs, deep spiny eel	x	x	x	bathypelagic/benthopelagic/bathydemersal
Ophidiiformes	Cusk eels		x	x	demersal/bathydemersal/benthopelagic
Osmeriformes	Capelin, eulachon, pond smelt	x	x	x	all portions of water column
Perciformes	Cod icefish	x	x	x	all portions of water column

Order	Representative Species	Proposed Action Area			Distribution in the Water Column
		Arctic	Antarctic	Pacific Northwest	
Petromyzontiformes	Pacfic lamrey, Arctic lamprey	x	x	x	demersal
Pleuronectiformes	Arctic flounder, Longheaded dab	x	x	x	demersal/bathydemersal
Rajiformes[1]	Skates, guitarfish	x	x	x	demersal/bathydemersal
Saccopharyngiformes	Bobtail eel			x	bathypelagic
Salmoniformes	Salmon, trout, whitefish, char	x		x	pelagic/benthopelagic/demersal
Scorpaeniformes	Snailfish, rockfish	x	x	x	demersal/bathydemersal
Squaliformes[1]	Dogfish sleeper shark	x		x	benthopelagic
Squatiniformes[1]	Angel shark			x	demersal
Stephanoberyciformes	Whalefish, bigscales	x	x	x	bathypelagic
Stomiiformes	Bristlemouth	x	x	x	bathypelagic
Syngnathiformes	Slender snipefish,			x	oceanic-pelagic/reef associated/demersal
Tetraodontiformes	Trigger fish, file fish, puffers			x	oceanic-pelagic/benthopelagic
Torpediniformes[1]	Electric rays			x	demersal
Zeiformes	Dories, rosy dory	x	x	x	bathydemersal/benthopelagic

[1]Defined under class Chondrichthyes

3.2.3.1 Arctic Proposed Action Area Overview

The nearshore areas surrounding Alaska consist of fish habitats such as rocks, kelp, epipelagic waters, intertidal beaches, subtidal shelves, and deeper bay bottoms. These habitats serve as important spawning and nursery grounds for juveniles of numerous demersal and pelagic fish species (Rogers 1986; Rogers et al. 1986). These species include high seas salmon (*Oncorhynchus spp.*), walleye pollock (*Gadus chalcogrammus*), Pacific (*Gadus microcephalus*) and Arctic cod, flatfish, and various forage species (Mueter 2004). The life histories of many of these species are closely tied to the currents, which transport eggs and larvae, as well as to ice, which provides habitat, and plays a critical role in plankton bloom dynamics, which support the food web (Beamish et al. 2005; Lynghammar et al. 2013; Wyllie-Echeverria and Wooster 1998). Arctic cod (NPFMC 2009) is a keystone species for the region because of its broad distribution, high abundance, and importance as a prey species for other fish, mammals, and seabirds.

Arctic deepwater environments also support a diverse assemblage of fish, though primarily in "hotspots" of benthic diversity. Although this environment is generally poorly studied, well over 200 fish species, dominated by various families of Scorpaeniforms have been documented in bathypelagic and bathydemersal environments of the arctic, accounting for approximately 90 percent of the overall fish species richness of the region (Johannesen et al. 2012).

3.2.3.1.a Order Gadiformes (Cod)

Gadoids (cods and codlike fishes) are an important component in the food web of most temperate and boreal environments, preying on primary producers such as plankton, and being preyed upon by a wide range of marine mammals and birds (including gulls and guillemots) (Bluhm and Gradinger 2008; Cohen et al. 1990; Welch et al. 1993). Various species of cod can be found in both the Arctic and Pacific Northwest proposed action areas, including the Arctic cod, which is closely associated with sea ice.

Arctic cod is the northernmost occurring fish species and is widespread throughout Arctic seas (Mecklenburg et al. 2013). Arctic cod are both cryopelagic (live in cold, deep water) and epontic (live on the underside of ice). They use sea ice for shelter, to capture prey, and to avoid predators. Arctic cod often occur in ice holes, cracks, hollows, and cavities in the lower surface of the ice and are most common near the ice edge or among broken ice. As the ice thaws at these margins, plankton grows and provides a food source. They occur in the open-ocean waters of the proposed action area from the surface to depths of 1,300 ft (400 m). The primary offshore food source of Arctic cod are epibenthic mysids, amphipods, copepods, and fish (Cohen et al. 1990). This species moves and feeds in different groupings, dispersed in small and very large schools throughout the water column (Welch et al. 1993). In a recent otter trawl survey in the Chukchi Sea, Arctic cod accounted for 96 percent of the total catch (Mecklenburg et al. 2013).

Polar cod are primarily found in the Arctic Ocean (Mecklenburg et al. 2011) and are distributed north of the Bering Strait throughout the Arctic proposed action area. Polar cod are associated with ice and are found mainly in offshore waters, at or beyond the edge of the continental shelf where they are abundant (Mecklenburg et al. 2013). Polar cod are also cryptopelagic or epontic with a depth range of 0 to 3,280 ft (0 to 1,000 m). Saffron cod (*Eleginus gracilis*) occur from the surface to 980 ft (300 m) in the open-ocean and coastal waters of the Arctic proposed action area. Adults spawn inshore during the winter and feed offshore in the summer. Additionally, Pacific cod and walleye pollock, both common groundfish occurring from the surface to 4,200 ft (1,280 m) in the Bering Sea, have been found in recent surveys of the Chukchi Sea (Norcross et al. 2013).

Pacific cod (*Gadus macrocephalus*) and Pacific tomcod (*Microgadus proximus*) are the most common gadoid fishes in the Pacific Northwest proposed action area. Both are generally found in continental shelf and slope environments (less than 3,300 ft [1000 m]), and so would be restricted to the small shallower portion in the northeast corner of the Pacific Northwest proposed action area. Both species also extend in range into the southern Bering Sea, and thus, may also be observed in the Arctic proposed action area.

3.2.3.2 Antarctic Proposed Action Area Overview

The Antarctic benthic fish community has a stable composition of species that are unique to this environment. Many species are endemic, found nowhere else in the world, and highly adapted for life in the dark cold waters of the Ross Sea (Clarke and Johnston 2003; Smith et al. 2014). Many species live in a wide range of depths and have slow growth rates, a common trait for cold, lower productivity environments (Smith et al. 2007). The most abundant group of fishes in the proposed action area are the cod icefish (members of the order Perciformes in family Nototheniidae). Most Ross Sea fish are benthic, or cryopelagic (ice associated), with the exception of two important species, the commercially harvested Antarctic toothfish (*Dissostichus mawsoni*) and the Antarctic silverfish (*Pleuragramma antarcticum*). Silverfish are a major consumer of euphausiids (mainly crystal krill*),*and are prey of almost every upper-trophic-level predator over the shelf, including penguins and toothfish, which in turn are fed upon by Weddell seals (*Leptonychotes weddellii)* and killer whale (*Orcinus orca)* (Ainley and Pauly 2014; La Mesa and Eastman 2012; Smith et al. 2014).

3.2.3.3 Pacific Northwest Proposed Action Area Overview

The Pacific Northwest proposed action area is in the northern portion of the California current ecosystem and the very southern extent of the Gulf of Alaska ecosystem. Thus, this is an area of overlap that is near the northern extent of many temperate species, and at the southern edge of the range of most boreal species (Hogan 2011; Mueter 2004). The proposed action area also includes a range of habitats: a small portion of continental shelf and continental slope; parts of the Juan de Fuca canyon system; and, the abyssal plain, which all provide important habitat for a wide range of pelagic, demersal, and baythdemersal fish assemblages.

The offshore upwelling regions within the proposed action area provide important feeding grounds for several species of salmonids, including coho salmon (*Oncorhynchus kisutch*), chum salmon (*Oncorhynchus keta*), and Chinook salmon (*Oncorhynchus tshawytscha*), which are born in the streams of Oregon, California, and Washington (Duffy et al. 2005; Rice et al. 2012). The region also supports a tremendous array of rockfishes (Order Scorpaeniformes), with as many as 60 species occurring in the proposed action area (Froese and Pauly 2013; Love et al. 2002; Williams et al. 2010). Fish in this area possess diverse life histories and inhabit a broad range of habitats, ranging from nearshore demersal species, to deep water bathydemersal species, to pelagic species (DFW 2011). Many of these species are commercially and recreationally important fisheries species, and many are severely depleted in population, though others appear to be naturally rare (DFW 2011; Williams et al. 2010).

The proposed action area also hosts an abundance of pelagic forage fish, such as Pacific herring (*Clupea pallasii*), surf smelt (*Hypomesus pretiosus*), and Pacific sand lance (*Ammodytes hexapterus*). These forage fish in turn support robust bird populations and higher trophic level fisheries(Rice et al. 2012).

3.2.3.4 ESA-Listed Fish Species

A general description of habitat preference and life history of all ESA-listed species that may occur within the proposed action areas are provided in this section. Table 3-4 summarizes these species and where they may be encountered. No ESA-listed species have designated critical habitat within any of the proposed action areas. Table 3-4 also provides a list of those species where individuals would be expected to be encountered in this proposed action area, but those individuals would not be expected to be from the ESA-listed population and details are provided below.

Table 3-4. ESA-Listed Fish Species Found within the Proposed Action Areas

Species	Listing Status	Likelihood of Occurrence in Proposed Action Areas		
		Arctic	Antarctic	Pacific Northwest
Bocaccio *(Sebastes paucispinus)*	Endangered	Not Expected	Not Expected	Likely
Chinook Salmon (*Oncorhynchus tshwytscha)*	Endangered (Sacramento River Winter-run, Upper Columbia River Spring-run); Threatened (Snake River Spring/Sumer-run, Snake River Fall-run, Central valley Spring-run, California Coastal, Puget Sound, Lower Columbia River, Upper Willamette River)	Likely*	Not Expected	Likely
Chum Salmon (*Oncorhynchus keta*)	Threatened (Hood Summer-run, Columbia River)	Likely	Not Expected	Likely
Coho Salmon (*Oncorhynchus kisutch)*	Endangered (Central California Coast); Threatened (Southern Oregon/Northern California Coasts, Lower Columbia River, Oregon Coast)	Likely*	Not Expected	Likely
Pacific Eulachon (*Thaleichthys pacificus)*	Threatened	Likely*	Not Expected	Likely
Sockeye Salmon (*Oncorhynchus nerka)*	Endangered (Snake River); Threatened (Ozette Lake)	Likely*	Not Expected	Likely
Steelhead Trout (*Oncorhynchus mykiss)*	Endangered (Southern California); Threatened (Upper Columbia River, Snake River Basin, Middle Columbia River, Lower Columbia River, Upper Willamette River, South-Central California Coast, Central California Coast, Northern California, California Central Valley, Puget Sound)	Likely*	Not Expected	Likely
Yelloweye Rockfish (*Sebastes ruberrimus)*	Threatened	Potential	Not Expected	Likely

* Although individuals from this species would be expected to be encountered in this proposed action area, individuals from the ESA-listed population would not be expected.

3.2.3.4.a Bocaccio

The Puget Sound/Georgia Basin Distinct Population Segment (DPS) of bocaccio (*Sebastes paucispinus*) was listed as endangered by NMFS (74 FR 18516; April 23, 2009), and individuals from this DPS may occur in the Pacific Northwest proposed action area. In 2015, critical habitat was designated for the Puget Sound/Strait of Georgia DPS (79 FR 68042; November 13, 2014); however, the designated critical habitat does not overlap with the proposed action area. Historic data indicates that the bocaccio has always been a rare species near the proposed action area, and sightings are very infrequent, though the population is not thought to be completely extirpated at this time (Palsson et al. 2009; Williams et al. 2010). Bocaccio in general can be found from Alaska to Baja California, but the Pacific Northwest proposed action area is the only area in which the ESA-listed species is likely to be found. NMFS published a recovery plan for Puget sound/Georgia Basin Yelloweye Rockfish (*Sebastes ruberrimus*) and Bocaccio on October 13, 2017 (NMFS 2017b).

Larval young are found in surface waters and may be distributed over a wide area. Larvae and small juvenile rockfish offshore may remain in open waters for several months, being passively dispersed by ocean currents. As adults, densities of bocaccio are highest near rocky habitats, but they have also been documented along areas of high relief and non-rocky substrates such as sand, mud, and other unconsolidated substrates. Adult bocaccio are most frequently found between 160 and 820 ft (50 and 250 m), but may be found as deep as 1,560 ft (475 m) (National Marine Fisheries Service 2015). Larval and juvenile bocaccio are opportunistic feeders, consuming a variety of zooplankton, including fish larvae, copepods, krill and euphausiids. Adults are primarily piscivores (National Marine Fisheries Service 2015).

3.2.3.4.b Chinook Salmon

The Upper Columbia River spring-run and Sacramento River winter-run evolutionarily significant units (ESUs) of Chinook salmon (*Oncorhynchus tshwytscha)* are listed as endangered under the ESA (79 FR 40004; July 11, 2004 and 59 FR 440; January 4, 1994). Seven other ESUs, including California Coastal and Central Valley spring-run are listed as threatened (81 FR 51549; August 4, 2106) (National Marine Fisheries Service 2014a). NMFS has published recovery plans for multiple Chinook salmon ESUs (NMFS 2006, 2007b, 2011b, 2013a, 2016a). Critical habitat has been designated in streams and rivers along the Pacific Coast of the continental United States, but does not overlap with any of the proposed action areas. Sacramento River winter-run Chinook salmon are listed as endangered and Sacramento River spring-run are listed as threatened by the state of California. Chinook salmon are likely to occur within the Arctic and Pacific Northwest proposed action areas; however, individuals from listed stocks rarely extend further north, and individuals captured further north are virtually exclusively from Alaskan natal stocks. Thus, the likelihood of encountering an ESA-listed fish, in the Arctic proposed action area is extremely low.

Juvenile Chinook salmon migrate to marine waters after three months to two years (National Marine Fisheries Service 2014a) and prefer coastal areas less than 34 miles (mi; 54 kilometers [km]) from shore throughout California, Oregon, and Washington, north to the Strait of Georgia and the Inland Passage, Alaska (PFMC 2000). The majority of marine juveniles are found within 17 mi (34 km) of the coast (PFMC 2000), tending to concentrate around areas of pronounced coastal upwelling (PFMC 2000). Chinook salmon return to estuarine waters in early spring, shortly before moving upriver to spawn (Keefer et al. 2008). Chinook spawning in rivers south of the Rogue River in Oregon rear in marine waters off California and Oregon, whereas, salmon spawning in rivers north of the Rogue River migrate north and west along the Pacific coast (NOAA 2005). These salmon migrations are important from a management perspective as fish from Oregon, Washington, British Columbia, and Alaska could potentially be harvested in Alaska (NOAA 2005). Within Alaska, early life history stages of Chinook salmon occur in freshwater and juveniles and adults utilize marine habitats. Juvenile Chinook salmon feed on terrestrial and aquatic insects, amphipods, and other crustaceans. Adult Chinook salmon feed primarily on other fish species (AECOM 2013).

3.2.3.4.c Chum Salmon

Columbia River and Hood Canal summer-run ESUs of chum salmon (*Oncorhynchus keta*) are listed as threatened under the ESA (70 FR 37160; June 28, 2005). Recovery plans were published for both chum salmon ESUs in 2005 and 2013, respectively (Brewer et al. 2005; NMFS 2013c). Designated critical habitat for chum salmon does not overlap with any of the proposed action areas, as it occurs within coastal water bodies in the states of Washington and Oregon (70 FR 52630; September 2, 2005). Chum salmon are likely to occur within the Arctic and Pacific Northwest proposed action areas; however, individuals from listed stocks rarely extend further north, and individuals captured further north are virtually exclusively from Alaskan natal stocks. Thus, the likelihood of encountering an ESA-listed fish, in the Arctic proposed action area is extremely low.

Chum salmon have the largest range of natural geographic and spawning distribution of all the Pacific salmon species (Pauley et al. 1988). Juvenile chum salmon occur along the coast of North America and Alaska in a band that extends out to 22 mi (36 km) from shore (Salo 1991). Chum salmon are an anadromous species distributed throughout the North Pacific Ocean and Bering Sea (Salo 1991). They are highly migratory with fry heading seaward immediately after emergence (NPFMC 1990; Salo 1991). Chum salmon do not have the clearly defined smolt stages that occur in other salmonids; however, they are capable of adapting to seawater soon after emergence from the gravel (Salo 1991). Migrations of juvenile chum salmon are correlated with the warming of nearshore waters (Salo 1991). Within the Gulf of Alaska, early life history stages for chum salmon occur in freshwater, but juveniles and adults utilize marine habitats. Juvenile chum salmon migrations follow the Gulf of Alaska coastal belt to the north, west, and south during their first summer at sea (Salo 1991). Juvenile chum salmon within the Gulf of Alaska tend to move offshore into the central Gulf of Alaska or westward along the Aleutian Islands into the North Pacific ocean and the Bering Sea as they mature (Urawa et al. 2009). Migrations of immature fish during the late summer, fall, and winter occur in a broad southeasterly fashion, primarily south of 50° N and east of 155° W in the Gulf of Alaska. During the spring and early summer, chum salmon migrate to the north and west (Salo 1991). Maturing fish destined for North American streams are widely distributed throughout the Gulf of Alaska during the spring and summer (Salo 1991).

Young chum salmon feed on a variety of aquatic insects during their run from natal streams down to the ocean. While rearing in estuarine environments, juvenile chum salmon eat primarily epibenthic invertebrates, including copepods, amphipods, mysids, and other crustaceans (Brewer et al. 2005; NMFS 2013c).

3.2.3.4.d Coho Salmon

Three ESUs of coho salmon (*Oncorhynchus kisutch*) are listed as threatened under the ESA, and the Central California coast ESU is listed as endangered (70 FR 37160; June 28, 2005; 76 FR 35755; June 20, 2011). NMFS published recovery plans for the Southern Oregon/Northern California Coast ESU in 2014 (NMFS 2014), the Lower Columbia ESU in 2013 (NMFS 2013a), and for the Central California coast ESU in

2012 (NMFS 2012b). Designated critical habitat for coho salmon does not overlap with any of the proposed action areas (central California coast ESU: 64 FR 24049; May 5, 1999; Oregon coast ESU: 73 FR 7816; February 11, 2008; lower Columbia River ESU: 81 FR 9251; February 24, 2016). Coho salmon are likely to occur within the Arctic and Pacific Northwest proposed action areas. However, individuals from listed stocks rarely extend further north than Puget Sound, and individuals captured further north than the Yakutat region of Alaska are virtually exclusively from Alaskan natal stocks. Thus, it would be extremely uncommon to encounter a fish from a listed stock in the Arctic proposed action area (Adams et al. 2007; Weitkamp and Neely 2002).

Coho salmon spawn in freshwater drainages from Monterey Bay, California northwards along the west coast of North America up to Alaska, around the Bering Sea south through Russia to Hokkaido, Japan (CDFG 2002). Oceanic life stages are found from Baja California north to Point Hope, Alaska and through the Aleutian Islands (Marine Biological Consultants 1987; NOAA 2005; Sandercock 1991). Adult coho salmon migrate into streams where they deposit their eggs in gravel (Sandercock 1991). Eggs incubate throughout the winter and emerge in the spring as free-swimming fry (Sandercock 1991). The duration and timing of migration is variable and somewhat latitude-dependent.

In Alaska, coho salmon spend up to four months in coastal waters before migrating offshore (NOAA 2005; Spence and Hall 2010). The extent of coho salmon migrations appears to extend westward along the Aleutian Islands chain ending somewhere around Emperor Seamount, which is thought to be an area of high prey abundance (PFMC 2000). Coho salmon spend a minimum of 18 months at sea before returning to their natal streams to spawn (NPFMC 1990; Sandercock 1991).

In the Pacific Northwest, coho salmon begin migrating upstream in the fall. Fry emerge from the gravel in spring, and spend one year in freshwater, before migrating to the ocean during the following spring. Immature fish remain in inshore areas, but mature fish may migrate to join schools from Washington and/or Oregon, before returning to their natal streams two years later to spawn (Adams et al. 2007; California Department of Fish and Wildlife 2016).

Coho salmon eat a variety of aquatic and terrestrial insects and invertebrates while rearing and have been observed leaping from the water to capture flying insects. Coho salmon rapidly transition to piscivory, including cannibalism, to supplement their diet during their extended overwinter rearing interval. Oceanic coho salmon eat a variety of small fish, as well as larger invertebrates including amphipods, isopods, and euphausiids (California Department of Fish and Wildlife 2016; CDFG 2002; Miller and Simenstad 1997; Sandercock 1991).

3.2.3.4.e Pacific Eulachon

The Southern DPS of eulachon (*Thaleichthys pacificus*) is listed as threatened under the ESA (75 FR 13012; March 18, 2010). Critical habitat for the southern DPS of eulachon has been designated in the Lower Columbia River (76 FR 65324; October 20, 2011), but does not overlap any of the proposed action areas. Eulachon are likely to occur within the Arctic and Pacific Northwest proposed action areas; however, eulachon occurring in the Arctic proposed action area are virtually exclusive from the unlisted Northern DPS, which utilizes Canadian and Alaskan natal streams. Thus, the likelihood of encountering a listed fish from the Southern DPS, which utilize natal streams in the continental United States, in the Arctic proposed action area is extremely low (Flannery et al. 2013; Gustafson et al. 2016; National Oceanic and Atmospheric Administration 2014). NMFS published a recovery plan for the Southern DPS of eulachon in 2017 (NMFS 2017a).

Eulachon are endemic to the eastern Pacific Ocean, ranging from northern California to southern Alaska and into the southeastern Bering Sea. In the continental United States, most eulachon originate in the Columbia River Basin. Eulachon occur in nearshore ocean waters, except for the brief spring spawning runs into their natal streams. Spawning grounds are typically in the lower reaches of larger snowmelt-fed rivers with water temperatures ranging from 39 to 50° F (4 to 10° C) (National Oceanic and Atmospheric Administration 2014). Eulachon typically spend three to five years in saltwater before returning to freshwater to spawn from late winter through mid-spring. Eggs are fertilized in the water column. After fertilization, the eggs sink and adhere to the river bottom, typically in areas of gravel and coarse sand. Most eulachon adults die after spawning. Eulachon eggs hatch in 20 to 40 days. The larvae are then carried downstream and are dispersed by estuarine and ocean currents shortly after hatching. Juvenile eulachon move from shallow nearshore areas to deeper water and may be observed in depths up to 2,000 ft (600 m), but typically remain between 80 and 500 ft (25 and150 m) (Allen and Smith 1988). Eulachon are filter feeders, consuming primarily zooplankton (National Oceanic and Atmospheric Administration 2014).

3.2.3.4.f Sockeye Salmon

Sockeye salmon (*Oncorhynchus nerka*) are the third most abundant of the Pacific salmonids, but two ESUs, the Ozette Lake ESU, which is listed as threatened (64 FR 14528; March 25, 1999), and the Snake River ESU, which is listed as endangered (56 FR 58619; November 20, 1991), remain listed under the ESA (National Marine Fisheries Service 2016b). Designated critical habitat for sockeye salmon is located in Washington State, and does not overlap with any of the proposed action areas (Snake River ESU: 58 FR 68543; December 28, 1993; Lake Ozette ESU: 70 FR 52630; September 2, 2005). NMFS published a recovery plan for the Lake Ozette ESU in 2009 (NMFS 2009b) and a recovery plan for the Snake River ESU in 2015 (NMFS 2015). Sockeye salmon from listed ESU's are likely to be encountered in the Pacific Northwest proposed action area. However, sockeye occurring in the Arctic proposed action area are virtually exclusive from listed populations utilizing Canadian and Alaskan natal streams, and thus, the likelihood of encountering a listed fish from the two listed ESUs in the Arctic proposed action area is extremely low (Beacham et al. 2005; Wilcock et al. 2011).

Spawning is temperature-dependent and varies by location, generally occurring from August to December and peaking in October (Emmett et al. 1991). Sockeye salmon typically spawn in streams associated with lakes where the juveniles rear in the limnetic zone before they migrate to the ocean (Burgner 1991; Emmett et al. 1991). For this reason, the two largest spawning complexes are the Bristol Bay watershed in southwestern Alaska and the Fraser River watershed in British Columbia, both of which have extensive lake-rearing habitats accessible to sockeye salmon (Burgner 1991).

Seaward migrations in Alaska begin in mid-May in association with salinity gradients (NPFMC 1990). Ocean residency for sockeye salmon is from one to four years (Pauley et al. 1989). The diet of juvenile sockeye salmon includes insects and large zooplankton, while larger fish become more piscivorous, consuming fish such as sand lance, walleye pollock and squid (Farley et al. 2007).

3.2.3.4.g Steelhead Trout

Steelhead trout (*Oncorhynchus mykiss*) is an anadromous form of rainbow trout protected under the ESA. Of the 15 steelhead trout DPSs, one is listed as endangered, ten are listed as threatened, and one is an ESA species of concern (71 FR 834; January 5, 2006 and 81 FR 51549; August 4, 2006) (National Marine Fisheries Service 2014c). Critical habitat for steelhead trout is designated in areas of Oregon, Washington, Idaho, and California (70 FR 52488 and 70 FR 52630; September 2, 2005 and 81 FR 9251; February 24, 2016), but does not overlap with any of the proposed action areas. Steelhead trout are likely to be encountered within the shallower portions of the Pacific Northwest proposed action area, and may be encountered in southern portions of the Arctic proposed action area in Bristol Bay or along the Aleutian Islands (Good et al. 2005). NMFS has published recovery plans for multiple steelhead trout DPSs (NMFS 1997, 2007b, 2009a, 2011b, 2012d, 2013a, 2013c, 2016a). Of the listed steelhead trout, it is extremely difficult to differentiate between stocks when considering steelhead trout offshore; trout undergo substantial migrations offshore, although some fish may move farther due to distance between centers of high abundance and natal streams (Burgner et al. 1989). Taking the well-mixed nature of offshore trout distribution into consideration, it is probable that the majority of the listed steelhead trout present in the Pacific Northwest proposed action area originate from nearby coastal DPSs (Upper Willamette River DPS, Columbia River DPSs, Puget Sound DPS). However, it is unlikely that any of the listed steelhead trout would be present in the Arctic proposed action area as the ESA-listed stocks are situated in continental U.S. waters (NMFS 2007b, 2009a, 2011b, 2012d, 2013a, 2013c, 2016a).

The present distribution of steelhead trout extends from the Kamchatka Peninsula in Asia, east to Alaska and south to Southern California (Good et al. 2005). Steelhead trout may exhibit either an anadromous life style, or spend their entire life in freshwater (where they are commonly referred to as rainbow trout) (NMFS 1997). Most steelhead trout within the vicinity of the Pacific Northwest proposed action area are likely from the "winter" run that migrate to freshwater in the fall and winter, where they spawn within a few weeks or months (McEwan and Jackson 1996). Ocean-maturing steelhead trout typically spawn between December and April, with the peak between January and March, but migrating steelhead trout may be seen in the San Francisco Bay and Suisun Marsh and Bay as early as August (Leidy 2000). The ocean distributions for steelhead trout are not known in detail, but steelhead trout are caught only rarely in ocean salmon fisheries. Studies suggest that steelhead trout do not generally congregate in large schools as do other Pacific salmon species (Burgner et al. 1992; Groot and Margolis 1991).

Steelhead trout spend little time in estuaries and are abundant throughout the North Pacific and Gulf of Alaska (Emmett et al. 1991). In coastal Alaska, eggs and larvae of steelhead trout are found only in freshwater habitats, while the later life history stages (i.e., juveniles and adults) utilize the marine environment. In the spring, Alaskan steelhead smolt, leave their natal streams, and enter the ocean where they reside for one to three years before returning to spawn (NOAA 2005). Populations may return in July (summer-run) or in August, September, and October (fall-run) (NOAA 2005). Summer returns are rare in Alaska and are only found in a few southeast Alaska streams. Fall-run steelhead trout are much more common in Alaska, north of Frederick Sound (near Juneau). Steelhead trout also exhibit spring runs (April, May, and June), but they are predominately found in southeast Alaska.

Juvenile steelhead trout feed primarily on zooplankton. Adult steelhead trout feed on aquatic and terrestrial insects, mollusks, crustaceans, fish eggs, minnows, and other small fish species (National Marine Fisheries Service 2014c).

3.2.3.4.h Yelloweye Rockfish

The Puget Sound/Georgia Basin DPS of yelloweye rockfish (*Sebastes ruberrimus*) is listed as threatened under the ESA (75 FR 22276; April 28, 2010) and may occur throughout the Pacific Northwest proposed action area and in the far southern reaches of the Arctic proposed action area. Critical habitat for the Puget Sound/Strait of Georgia yelloweye rockfish DPS is the same as critical habitat designated in 2015 for bocaccio (79 FR 68042; November 13, 2015). Critical habitat does not overlap with any of the proposed action areas. Yelloweye rockfish are present through the Aleutian Islands, and thus, may be encountered at the southern edge of the Arctic proposed action area, though they are most common from central California through the Gulf of Alaska and would likely be encountered in the Pacific Northwest proposed action area. NMFS published a recovery plan for Puget sound/Georgia Basin Yelloweye Rockfish and Bocaccio on October 13, 2017 (NMFS 2017b).

Yelloweye rockfish larval release occurs between February and September. The larval young are found in surface waters and may be distributed over a wide area extending several hundred miles offshore. Their survival is affected by ocean conditions such as temperature, currents, and the availability of food. Larvae and small juvenile rockfish may remain in open waters for several months, being passively dispersed by ocean currents. Yelloweye rockfish juveniles, unlike bocaccio, do not typically occupy shallow, intertidal areas, but settle in deeper waters from 300–590 ft (91–180 m) (Drake et al. 2010). Yelloweye rockfish are among the longest lived rockfishes and can live over 100 years (Williams et al. 2010). Juveniles rockfish consume a variety of large marine zooplankton (e.g., copepods and euphausiids), while adults are primarily piscivorous, with large adult yelloweye rockfish considered apex predators (Love et al. 2002).

3.2.3.5 Fish Hearing Sensitivity

All fish have two sensory systems to detect sound in the water: the inner ear, which functions very much like the inner ear in other vertebrates, and the lateral line, which consists of a series of receptors along the fish’s body (Popper 2008). The inner ear generally detects relatively higher-frequency sounds, while the lateral line detects water motion at low frequencies (Hastings and Popper 2005).

Although hearing capability data only exist for fewer than 100 of the 32,000 fish species, current data suggest that most species of fish detect sounds from 50 to 1,000 Hz. It is believed that most fish have their best hearing sensitivity from 100 to 400 Hz (Popper 2003). While all fishes respond to the particle motion component of sound, regardless of whether they can “hear,” some fish species possess anatomical specializations that may enhance their sensitivity to pressure changes (Popper 2014). These adaptations allow some fish species such as clupeids (herrings, shads, sardines, anchovies) the ability to sense higher frequencies and lower intensities, hearing sounds above 4 kHz (Popper 2008; Popper and Fay 2010). ESA-listed species within the proposed action areas are not hearing specialists. In general, the range of best hearing for salmon species, including steelhead, is below 380 Hz. There is no reliable hearing data on eulachon or rockfish species, but anatomically, they are hearing generalists, and so, likely to behave similarly (Hastings and Popper 2005; Popper 2003). Additionally, some clupeids (e.g., shad in the subfamily Alosinae) possess ultrasonic hearing (i.e., able to detect sounds above 100 kHz) (Astrup 1999). Despite this capability, the best hearing sensitivity for clupeids is generally at frequencies less than 1 kHz (Mann et al. 1998; Popper 2008; Popper and Fay 2010). Some gadoid fish have also been shown to be hearing specialists, capable of hearing sounds above 4 kHz. Cod have also shown to be pressure-sensitive (Popper 2014).

3.2.4 Essential Fish Habitat

To protect fisheries resources, NMFS works with regional fishery management councils to identify EFH for every life stage of each federally managed species using the best available scientific information. According to NMFS, EFH has been described for approximately 1,000 managed species to date. EFH includes all types of aquatic habitat including wetlands, coral reefs, seagrasses, and rivers: all locations where fish spawn, breed, feed, or grow to maturity. EFH is included in Fishery Management Plans (FMPs) and NMFS is responsible for approving and implementing FMPs under the Magnuson-Stevens Act. Within the proposed action areas, EFH is designated within the Arctic and the Pacific Northwest proposed action areas only.

A subset of EFH are Habitat Areas of Particular Concern (HAPC). Fishery management councils designate HAPC under the Magnuson-Stevens Act. HAPC are identified based on habitat level considerations rather than species life stages, which are associated with EFH designations. FMPs identify habitats or areas within EFH as HAPCs based on the following considerations: the importance of the ecological function provided by the habitat, the extent to which the habitat is sensitive to human-induced environmental degradation, whether (and to what extent) development activities are, or would be, a stress to the habitat type, or the rarity of the habitat type. HAPCs must meet at least two of the previous considerations; but rarity of the habitat is a mandatory criterion. EFH and HAPCs, where applicable, are described in detail below.

3.2.4.1 Arctic Proposed Action Area EFH

The North Pacific Fishery Management Council (NPFMC) has fishing regulatory jurisdiction over Alaska's 0.89 million mi^2 (2.3 million km^2) EEZ. The NPFMC manages fisheries in the Bering Sea, Aleutian Islands, and Gulf of Alaska and has developed six FMPs to achieve specified management goals for a fishery. Within the Arctic proposed action area, the Crab (NPFMC 2011), Groundfish (NPFMC 2017), Salmon (NPFMC 2012a), and Scallop (NPFMC 2014) FMPs are applicable. There is also an Arctic FMP (NPFMC 2009) and draft Amendment to this Arctic FMP (Amendment 2, March 5, 2018), which closed Federal waters of the U.S. Arctic to commercial fishing for any species of finfish, mollusk, crustacean, or any other form of marine animal or plant life. The harvest of marine mammals or birds is not regulated by the Arctic FMP, nor is subsistence or recreational fishing. EFH for all species with designated habitat within the proposed action area (Figure 3-3), along with the relevant life history stages is shown in Table 3-5.

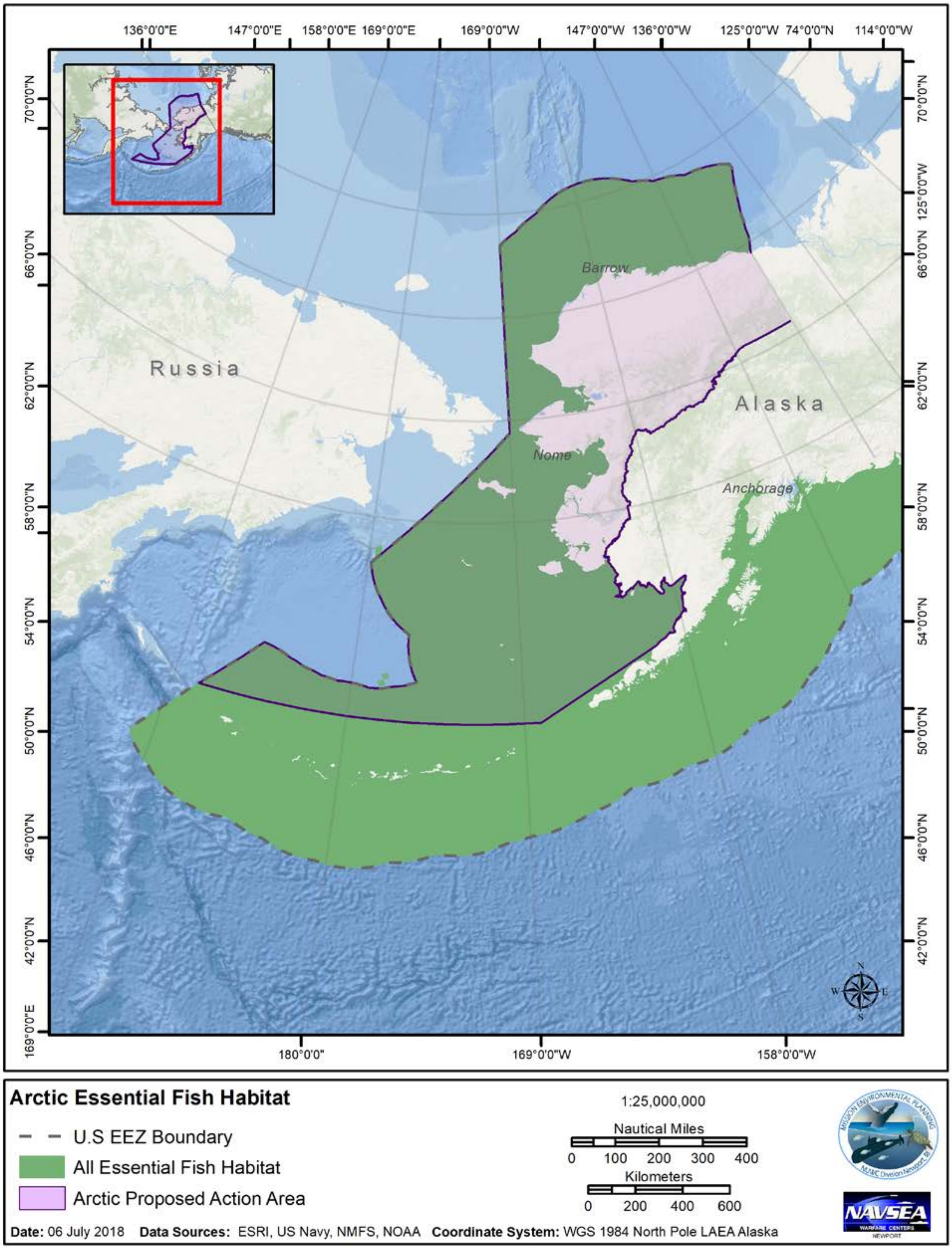


Figure 3-3. EFH within the Arctic Proposed Action Area

3.2.4.1.a Crab EFH

Many commercially viable crab species, including red king and golden king crab (*Paralithodes camtschaticus* and *Lithodes aequispina*, respectively), as well as several species of tanner crab (*Chionoectes* spp.), can be found within the Arctic proposed action area. Seven species of crab have EFH within the proposed action area: blue king crab (*Paralithodes platypus*), golden king crab, grooved tanner crab (*Chionoecetes tanneri*), red king crab, snow crab, tanner crab (*C. bairdi*), and triangle tanner crab (*C. angulatus*). These species are predominantly fished in the Bering Sea, Aleutian Islands, and Bristol Bay region. EFH for all species of crab is detailed in the Bering Strait Aleutian Islands FMP and generally includes bottom habitat from 0–656 ft (0–200 m) in depth. Golden king crabs are the only species found outside of 656 ft (200 m), with their EFH including bottom habitat up to 9,843 ft (3,000 m). Depending on the species of crab, mud, high relief, or rocky substrate may be preferred. Within the Groundfish FMP (see Section 3.2.4.1.b), there are specific area closures to protect king and tanner crab habitat and molting grounds in the vicinity of Kodiak, Alaska, which is outside of the Arctic proposed action area.

3.2.4.1.b Groundfish EFH

Of the 66 groundfish species managed by the NPFMC, 23 are known to occur within the Arctic proposed action area. These groundfish species occupy various marine environments, including estuaries, tideland marshes, bays, fjords, sandy beaches, unprotected rocky shores, river deltas, and a variety of continental shelf, slope, seamount, and deep ocean habitats encompassing different physical and biological attributes at various stages in their life histories. The flatfishes have been divided into several categories for management purposes. With the exception of arrowtooth flounder (*Atheresthes stomias*), rex sole (*Glyptocephalus zachirus*), and flathead sole (*Hippoglossoides elassodon*), which are managed as individual species, the remaining flatfishes are managed as “shallow-water” and “deep-water” assemblages. Each of the managed individual species has its own EFH designation. EFH for most groundfish is located in the lower portion of the water column at depths of 0–3,281 ft (0–1,000 m). Only squid and Atka mackerel (*Pleurogrammus monopterygius)* have EFH designation that includes the entire water column. Preferred bottom substrates for groundfish range from mud to sand to rock. Arctic cod is the only species that has EFH associated with ice floes. EFH for all species with designated habitat within the proposed action area, along with the relevant life history stages, is shown in Table 3-5.

3.2.4.1.c Salmon EFH

Five species of Pacific salmon have EFH designated in the Arctic proposed action area: Chinook salmon, chum salmon, coho salmon, pink salmon (*Oncorhynchus gorbuscha*), and sockeye salmon. Salmon EFH includes streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon. Freshwater EFH, designated for the eggs and larval salmon, does not overlap with the proposed action area. The geographic extent of marine EFH for all salmon species stretches from the nearshore tidal submerged environments within state territorial seas out to the full extent of the EEZ, 200 nm offshore, which overlaps with the Arctic proposed action area. Chum, coho, pink, and sockeye salmon EFH is located in waters less than 656 ft (200 m) deep.

3.2.4.1.d Scallop EFH

NMFS and the Alaska Department of Fish and Game (ADFG) jointly manage scallops under the FMP for the scallop fishery off Alaska. The weathervane scallop (*Patinopecten caurinus*) is the only commercially exploited scallop in Alaska waters with EFH located within the Arctic proposed action area. EFH for the weathervane scallop is located along the Aleutian Island chain and in the southeast Bering Sea on the seafloor to depths of up to 656 ft (200 m).

Table 3-5. EFH Present in the Arctic Proposed Action Area

Species	Location	Life Stages
Scallops		
Weathervane scallop *Patinopecten caurinus*	S. Bering Sea, Aleutian Islands	all (eggs, immature, juveniles, adults)
Salmon		
Chinook salmon *Oncorhynchus tshawytscha*	Bering Strait south to Aleutians	all
Chum salmon *Oncorhynchus keta*	Bering Strait south to Aleutians	all
Coho salmon *Oncorhynchus kisutch*	Bering Strait south to Aleutians	all
Pink salmon *Oncorhynchus gorbuscha*	Bering Strait south to Aleutians	all
Sockeye salmon *Oncorhynchus nerka*	Bering Strait south to Aleutians	all
Crab		
Blue king crab *Paralithodes platypus*	Bering Sea	all
Golden king crab *Lithodes aequispinus*	Bering Sea, Aleutians	all
Grooved tanner crab *Chionoecetes tanneri*	Bering Sea	all
Red king crab *Paralithodes camtschaticus*	Norton Sound, Bering Sea, Bristol Bay	all
Snow crab *Chionoecetes opilio*	Bering Sea, Bering Strait, Chukchi Sea	all
Tanner crab *Chionoecetes bairdi*	Bering Sea	all
Triangle tanner crab *Chionoecetes angulatus*	Bering Sea	all
Groundfish		
Alaska plaice *Pleuronectes quadrituberculatus*	Bering Sea	all
Arctic cod *Arctogadus glacialis*	Bering Strait, Chukchi Sea, Beaufort Sea	all
Arrowtooth flounder *Atheresthes stomias*	Bering Sea	all
Atka mackerel *Pleurogrammus monopterygius*	Bering Sea, Aleutians	all
Dover sole *Solea solea*	Aleutians, Bering Sea	all
Dusty rockfish *Sebastes ciliatus*	Aleutians, Bering Sea	all

Species	Location	Life Stages
Flathead sole *Hippoglossoides elassodon*	Aleutians, Bering Sea	all
Greenland turbot *Reinhardtius hippoglossoides*	Aleutians, Bering Sea	all
Northern rockfish *Sebastes polyspinis*	Aleutians, Bering Sea	all
Pacific cod *Gadus macrocephalus*	Aleutians, Bering Sea	all
Pacific Ocean perch *Sebastes alutus*	Aleutians, Bering Sea	all
Rex sole *Glyptocephalus zachirus*	Aleutians, Bering Sea	all
Rock sole *Lepidopsetta bilineata*	Aleutians, Bering Sea	all
Saffron cod *Eleginus gracilis*	Bering Strait, Chukchi Sea	all
Sablefish *Anoplopoma fimbria*	Aleutians, Bering Sea	all
Sculpin *Cottus* sp.	Aleutians, Bering Sea	all
Shortraker and rougheye rockfish *Sebastes borealis and Sebastes aleutianus*	Aleutians, Bering Sea	all
Skate *Raja* sp. and Bathyraja sp.	Aleutians, Bering Sea	all
Squid *Cephalopoda* sp.	Aleutians, Bering Sea	all
Thornyhead rockfish *Sebastolobus macrochir*	Aleutians, Bering Sea	all
Walleye Pollock *Gadus chalcogrammus*	Aleutians, Bering Sea	all
Yelloweye rockfish *Sebastes ruberrimus*	Aleutians, Bering Sea	all
Yellowfin sole *Limanda aspera*	Aleutians, Bering Sea	all

3.2.4.1.e Habitat Areas of Particular Concern

In the Arctic proposed action area, amendments to the FMP for salmon fisheries, scallop fisheries, and groundfish fisheries have established the following HAPCs and Habitat Protection Areas (Figure 3-4): one Alaska Seamount Habitat Protection Area (Bowers Seamount), two areas within the Bowers Ridge Habitat Conservation Zone (Bowers Ridge and Ulm Plateau) (NPFMC 2005), and six skate nursery areas within the Bering Sea (NPFMC 2012b).

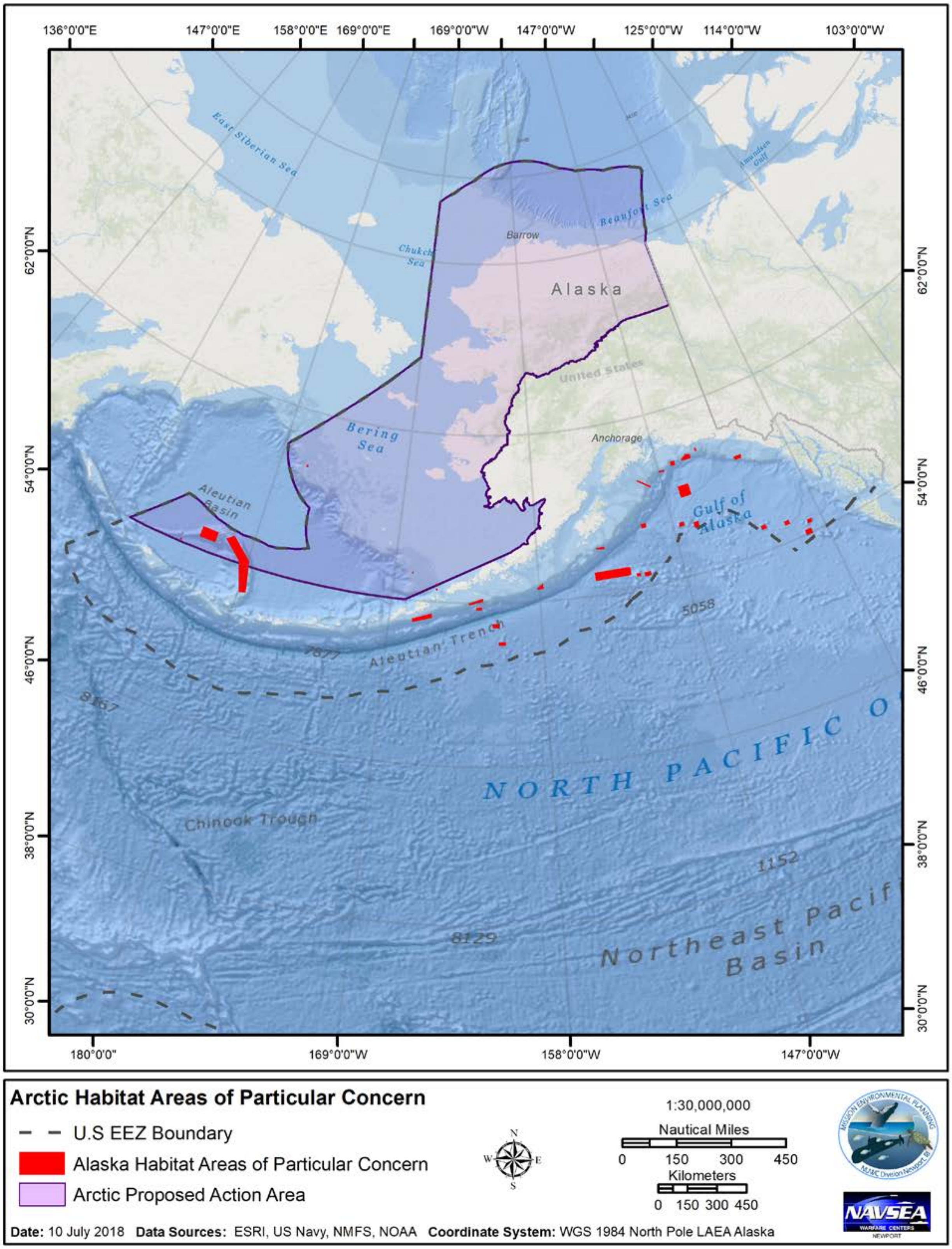


Figure 3-4. HAPC within the Arctic Proposed Action Area

3.2.4.2 Pacific Northwest Proposed Action Area EFH

EFH designated within the Pacific Northwest proposed action area can be found in Figure 3-5 and Table 3-6.

3.2.4.2.a Coastal Pelagic Fish

The coastal pelagic species FMP (PFMC 2016a) covers eight species of krill, four species of finfish, and market squid. Additional information regarding the finfish in the Pacific Northwest proposed action area can be found in Section 3.2.3.3. Finfish EFH includes pelagic and near surface waters ranging from less than 164 ft (50 m) for sardine and anchovy to depths of 2,625 ft (800 m) for market squid.

3.2.4.2.b Groundfish

The Pacific Coast Groundfish FMP (PFMC 2016c) (for the California, Oregon, and Washington Groundfish Fishery) was updated most recently in 2014, though it has been in place since 1982. The Pacific Coast Groundfish FMP manages 80-plus species over a large and ecologically diverse area. Information on the life histories and habitats of these species varies in completeness, so while some species are well-studied, there is relatively little information on other species. Information about the habitats and life histories of the species managed by the FMP would certainly change over time, with varying degrees of information improvement for each species. For these reasons, it is impractical for the Pacific Fishery Management Council to include descriptions identifying EFH for each life stage of the managed species in the body of the FMP. Therefore, the FMP includes a description of the overall area identified as groundfish EFH and describes the assessment methodology supporting this designation. Life histories and EFH identifications for each of the individual species are provided in Appendix B of the FMP. In general, EFH for rockfish includes nearshore, shelf, slope, and rise habitats in waters of 0–2,986 ft (0–910 m), typically benthic habitat with hard substrate. Flatfish EFH is generally bottom habitats in waters from 0–3,937 ft (0–1,200 m). Groundfish EFH is varied including some habitat within the water column, but most benthic habitat in waters from 0–2,953 ft (0–900 m), though the grenadier EFH includes habitat up to 9,268 ft (2,825 m). EFH of skates and sharks includes shelf and coastal habitat in ranges from waters depths of 0–5,249 ft (0–1,600 m). An overview of groundfish species common in the Pacific Northwest proposed action area can be found in Section 3.2.3.

3.2.4.2.c Highly Migratory Species

The highly migratory species FMP (PFMC 2016b) includes two species of tuna (albacore tuna [*Thunnus alalunga*], and northern bluefin tuna [*Thunnus thynnus*]) and two species of shark (blue shark [*Prionace glauca*], and common thresher shark [*Alopias vulpinus*]) found within the Pacific Northwest proposed action area. Additional information regarding the highly migratory species in the Pacific Northwest proposed action area can be found in Section 3.2.3. EFH for both types of tuna includes oceanic and epipelagic habitats in waters no shallower than 600 ft (183 m) and extending to the U.S. EEZ. EFH for both species of sharks includes near surface pelagic and epipelagic waters extending from the 6,000 ft (1,829 m) isobath to the U.S. EEZ.

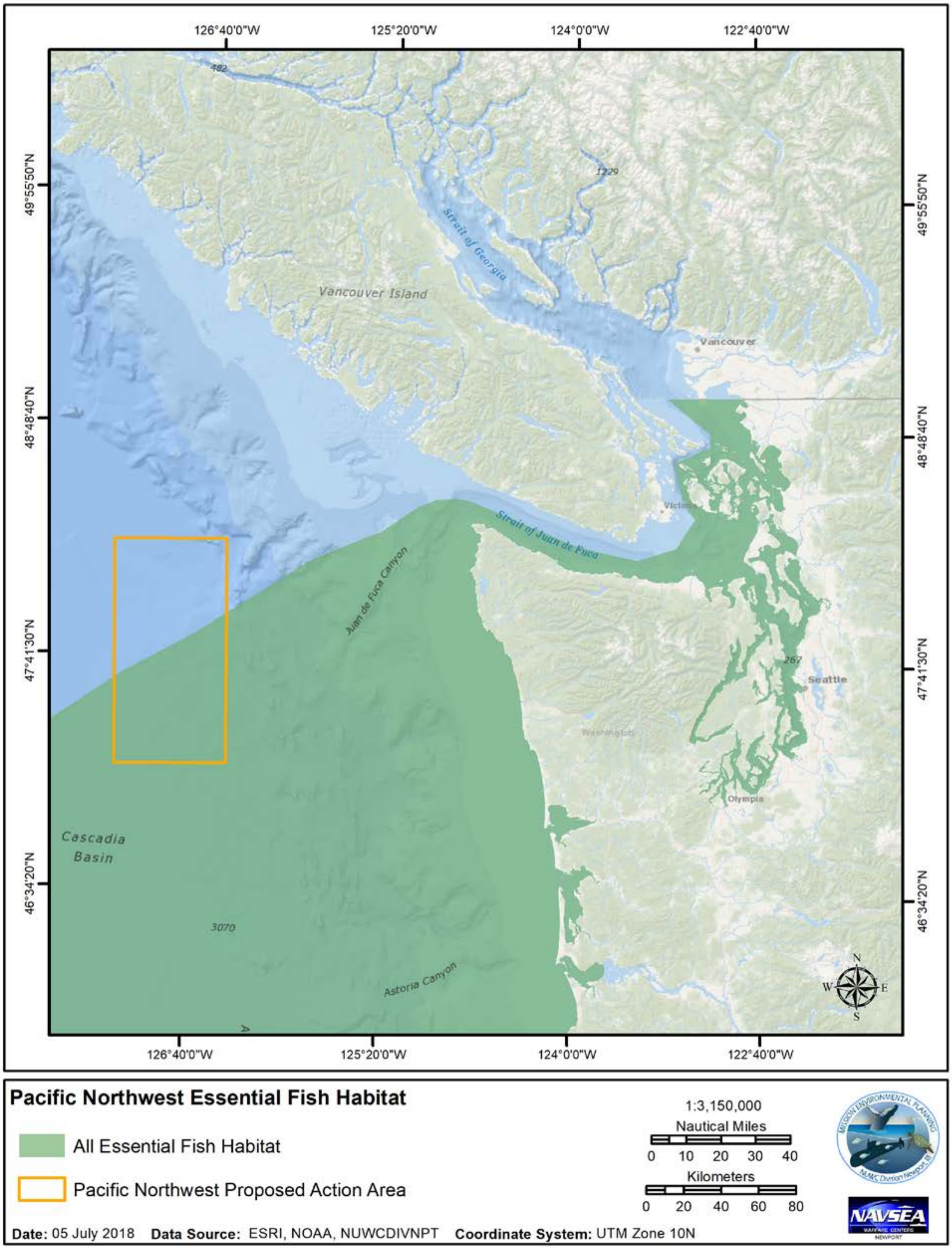


Figure 3-5. EFH within the Pacific Northwest Proposed Action Area

Table 3-6. EFH Present within the Pacific Northwest Proposed Action Area

Species	Life Stages
Coastal Pelagic Species	
Krill *Euphausia pacifica*	all (eggs, immature, juveniles, adults)
Krill *Thysanoessa spinifera*	all
Krill *Nyctiphanes simplex* *Nematocelis difficilis* *T. gregaria* *E. recurva* *E. gibboides* *E. eximia*	all
Pacific sardine *Sardinops sagax*	all
Pacific mackerel *Scomber japonicas*	all
Northern anchovy *Engraulis mordax*	all
Jack mackerel *Trachurus symmetricus*	adults
Market squid *Loligo opalescens*	all
Groundfish	
Flatfishes (flounder, sole, sanddab)	all
Rockfishes	all
Roundfish (lingcod, cabezon, kelp greenling, Pacific cod, Pacific hake, Pacific flatnose, Pacific grenadier)	all
Sharks, Skates, and Chimaeras	all
Highly Migratory Species	
Albacore tuna *Thunnus alalunga*	juveniles, adults
Northern Bluefin tuna *Thunnus orientalis*	juveniles, adults
Blue shark *Prionace glauca*	juveniles, adults
Common thresher shark *Alopias vulpinus*	adults

3.2.4.2.d Habitat Areas of Particular Concern

There are no HAPC that overlap with the Pacific Northwest proposed action area. Figure 3-6 shows the location of the Pacific northwest proposed action area and the adjacent HAPC.

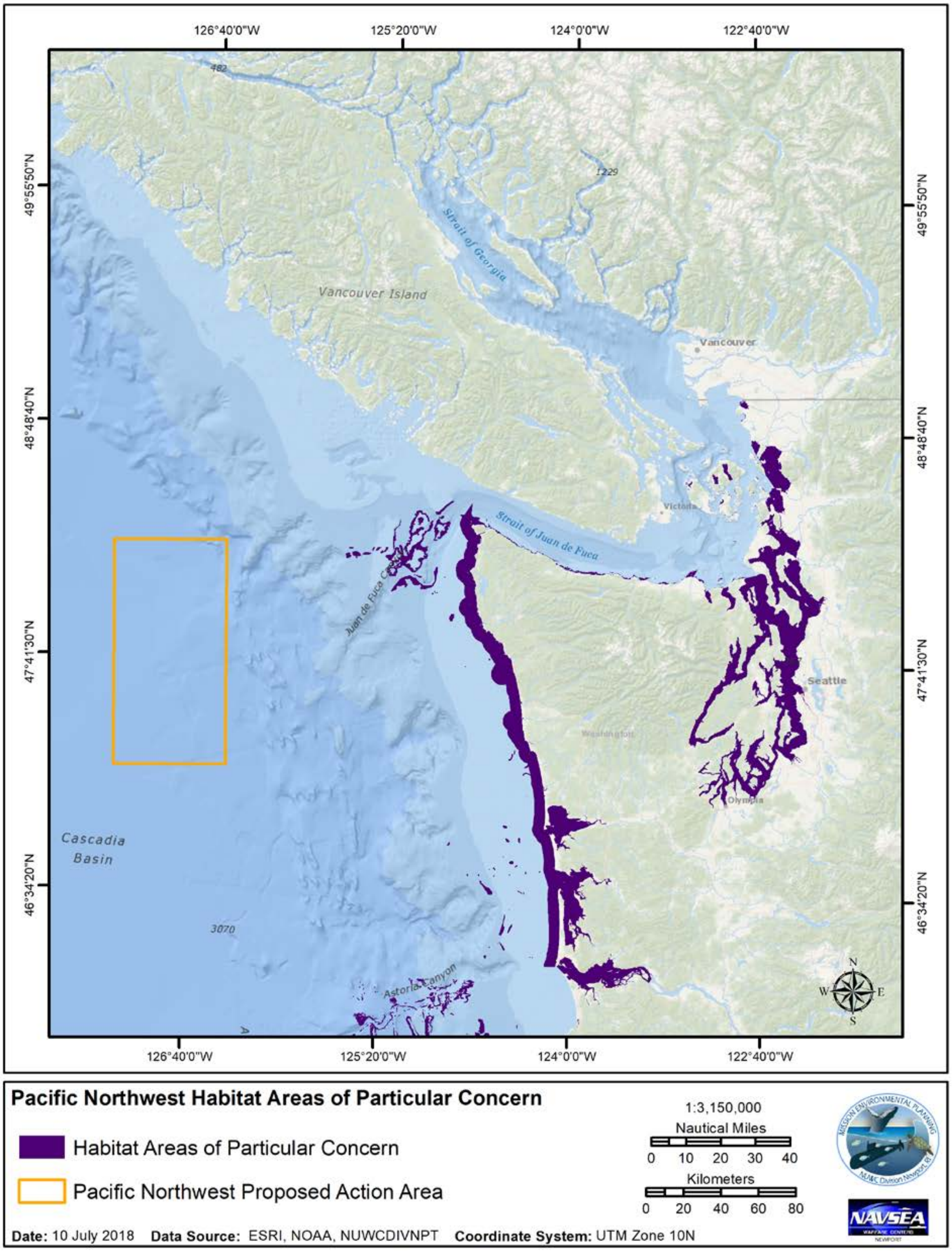


Figure 3-6. HAPC Adjacent to the Pacific Northwest Proposed Action Area

3.2.5 Seabirds and Shorebirds

For the purpose of this PEIS, "seabirds" refers to bird species which spend at least part of their life in the offshore, near-surface marine environment and those birds for whom sea ice is an important habitat. Thus, land-based birds and most shorebirds are excluded, even though the latter likely engage in high-altitude migrations (on the order of 0.6 mi [1 km]) over parts of the Arctic proposed action area (Alerstam et al. 2007; Alerstam and Gudmundsson 1999a; Alerstam and Gudmundsson 1999b; Gudmundsson et al. 2002). These high-altitude migrants are discussed in detail in Section 3.2.5.3. Non-migrating shorebirds may also be present in the Arctic proposed action area, and are discussed in Section 3.2.5.2.

Many seabirds spend most of their lives at sea and come to land only to breed, nest, and occasionally roost (Schreiber and Chovan 1986). Seabirds can be found in high numbers resting on the water surface in flocks where prey is concentrated (Enticott and Tipling 1997), including congregating around fishing vessels where they can feed on bycatch (Enticott and Tipling 1997; Onley and Scofield 2007) and oceanic fronts (gradients in current speed, temperature, salinity, density, and circulation) that bring prey species to the surface (Bost et al. 2009). Average seabird flight altitudes are about 33–130 ft (10–40 m), depending on the species, with most species flying at the lower end of this range (Cook et al. 2012; Day et al. 2005; Krijgsveld et al. 2005). In their study of flight speeds across all major seabird taxa (98 species total), Spear and Ainley (1997) recorded average ground speeds between 10.7 and 43.3 knots. The typical flight speeds of ESA-listed species range from 22 knots the average speed of albatross species (Alerstam et al. 1993); to eiders, flying at speeds of roughly 42 knots (Day et al. 2005); and, the marbled murrelet (*Brachyramphus marmoratus*), flying at speeds of more than 55 knots (Harper et al. 2004).

A combination of short-distance migrants, long-distance migrants, and year-round resident seabird species may occur within the proposed action areas. Typical behaviors that would be encountered predominantly include foraging, migrating, and resting.

Many birds undertake long migrations between their breeding and wintering areas. Their movements generally correspond to north-south oriented "flyways." The "flyways" concept mainly extends to land-based birds, shorebirds, and waterfowl; fewer seabird movements conform to these paths (UNEP/CMS Secretariat 2014). Flyway boundaries in general are not well defined, and there is considerable variation among species in their use of these spaces.

The following sections include general descriptions of the bird communities within each proposed action area, followed by descriptions of major taxonomic groups (see Section 3.2.5.1) and ESA-listed bird species (Table 3-8). All species likely to be encountered in the Pacific Northwest and Arctic proposed action areas, including ESA-listed species, are protected under the Migratory Bird Treaty Act (MBTA). Some species likely to be encountered in the Antarctic proposed action area are not listed under the MBTA (USFWS 2013a). General information on seabird and shorebird hearing in-air and underwater is discussed in Section 3.2.5.7.

3.2.5.1 Major Bird Groups

Over one hundred seabird species may occur within the proposed action areas. Table 3-7 describes the major orders of birds expected to be present in the Arctic, Antarctic, and Pacific Northwest proposed action areas, with the exception of penguins. These are discussed in detail in Section 3.2.5.4.a. Lists of seabird species were obtained from the 2013 Arctic Biodiversity Assessment (CAFF 2013), the North

Pacific Pelagic Seabird Database (Piatt and Drew 2015), and descriptions of the Ross Sea bird populations (Ainley et al. 2010a; Ainley et al. 1984). The presence of shorebirds is inferred from Alerstam et al. (2007), Alertsam and Gudmundsson (1999b), Alertsam and Gudmundsson (1999a), and Gudmundsson et al. (2002).

Table 3-7. Major Bird Groups Present in the Proposed Action Areas (except Penguins)

Order and/or Family	Notes	Representative Species/Diving Behavior	Proposed Action Area		
			Arctic	Pacific Northwest	Antarctic
Anseriformes (Diving Ducks)	Can be found in deeper water where they forage for food; some also forage on the ocean bottom in shallow water. Spectacled eider and king eider associate with offshore, dense pack ice.	Spectacled eider dives to 262.5 ft (80 m) (Petersen et al. 1998)	x	x	
Charadriiformes – Stercorariidae (Skuas/Jaegers)	Breed on land, but otherwise spend most of their lives at sea, with some undergoing extensive post-breeding transequatorial migrations. Some species do not dive at all; the remainder dive on occasion.	Pomarine jaeger swims underwater to retrieve offal. Brown skua is known to splash-dive for fish.	x	x	x
Charadriiformes – Sternidae (Terns)	Generally pelagic. Arctic tern breeds in the Arctic and winters in the Antarctic, including the Ross Sea.	Typically feed by surface dipping or shallow plunge dives.	x	x	x
Charadriiformes – Laridae (Gulls)	Closely related to terns, but tend to feed closer to shore. They engage in surface seizing, dipping, parasitic, and scavenging behaviors.	Some species exhibit occasional, shallow surface or plunge dives.	x	x	
Charadriiformes – Alcidae (Alcids/Auks)	Small oceanic species that come to land only to breed. Examples include puffins, auklets, guillemots, and murrelets. Form feeding aggregations in areas where food is concentrated.	Use wings to dive underwater. Some dive deeply: thick-billed murre reaches 689 ft (210 m) (Croll et al. 1992)	x	x	
Charadriiformes – Shorebirds/Waders	Represented by several different families. Small, generally long-legged. Most of their life cycle is spent in coastal areas; some also forage and migrate offshore (e.g. red phalarope).	Generally forage in intertidal areas by picking and probing for small aquatic prey.	x	x	
Gaviiformes (Loons)	Medium to large fish-eating birds. They move ashore to breed during the spring and summer. Winter in coastal, nearshore, or open water marine habitats. During migration, they fly high above land or water in loose groups or singly.	Capture prey by diving underwater. Loons can dive to 250 ft (76 m) with an average dive time of 40 seconds (Sibley 2007).	x	x	
Pelecaniformes (Cormorants)	Diverse group of large seabirds. Voracious predators on inshore fishes. offshore foraging range limited by their need for undisturbed, dry nocturnal roosting sites.	Generally excellent divers; the pelagic cormorant can dive to 328 ft (100 m) (Grémillet and Wilson 1999).	x	x	

Order and/or Family	Notes	Representative Species/Diving Behavior	Proposed Action Area		
			Arctic	Pacific Northwest	Antarctic
Procellariiformes – Diomedeidae (Albatrosses)	Large, far-ranging seabirds that are highly efficient in the air. Feed by scavenging, surface seizing, or in some cases by diving. Presence in Antarctic proposed action area is infrequent and not within pack ice (Ainley et al. 1984).	Large wings and light bodies generally limit their diving ability.		x	x
Procellariiformes – Pelecanoididae (Diving petrels)	Family has four members, all found only in the southern hemisphere. Only two (South Georgian diving petrel and the common diving petrel) range as far south as the Southern Ocean, possibly including the Antarctic proposed action area.	South Georgian diving petrel dives to 50–131 ft (15–40 m), common diving petrel to 75–164 ft (23–50 m) (Bocher et al. 2000)			x
Procellariiformes – Hydrobatidae (Storm-petrels) & Procellariidae (Fulmarine and gadfly	Storm-petrels pick prey off the surface while foraging. Fulmarine petrels feed by grabbing prey near the surface. Gadfly petrels zand are long-winged, fast-flying, and highly pelagic.	Do not dive for prey.	x	x	x
Procellariiformes - Shearwaters	Small- to medium-sized seabirds that exhibit varied diving behavior. For example, Buller's shearwater primarily feed just beneath the surface while sooty shearwaters (can dive to depths of 230 ft (70 m) (Enticott and Tipling 1997; Onley and Scofield 2007).	Varies.		x	x

3.2.5.2 Arctic Proposed Action Area Overview

The majority of Arctic bird species spend only a small amount of their time in these harsh, northerly latitudes. However, the summertime brings plentiful food (e.g., plants, zooplankton), continuous daylight, and reduced predation risk (McKinnon et al. 2010) resulting in a wide variety of breeding species. The highest breeding densities of pursuit-diving seabirds in the Northern Hemisphere occur in higher latitudes (Cairns et al. 2008).

At least forty-four species of seabirds breed in the Arctic (CAFF 2013), and almost all are represented within the bounds of the proposed action area. The majority of these species belongs to the order Charadriiformes and includes auks, puffins, gulls, terns, jaegers, and skuas. Loons (order Gaviidae) and cormorants (order Phalacrocoracidae) are also present. Some of these species have particular affinities for sea ice, which they use as a platform for resting and in some cases foraging (Eamer et al. 2013). Arctic seabirds most associated with ice include species of gulls, terns, and auks. The ivory gull (*Pagophila eburnea*) spends its entire life in the Arctic, where it forages along the ice edge for small fish, invertebrates, and zooplankton (Divoky 1976). Thick-billed murres (*Uria lomvia*) are also associated with ice cover, and remain in cold, northern latitudes throughout the year (Gaston et al. 2005). Finally, both spectacled eiders (*Somateria fischeri*) and king eiders (*Somateria spectabilis*) associate with offshore, dense pack ice in the winter (Mosbech et al. 2006; Petersen et al. 1999). They have been recorded 62 mi (100 km) and 43.5 mi (70 km) offshore, respectively (Mosbech et al. 2006; Petersen et al. 1999). Spectacled eiders (see Section 3.2.5.6.d) can dive to depths of over 262.5 ft (80 m) (Petersen et al. 1998), and king eiders have been recorded at up to 141 ft (43 m) deep (Mosbech et al. 2006).

Forty-seven species of shorebirds occur in Alaska, and thirty-seven of these regularly breed there. In addition to breeding grounds, Alaska also provides critical staging habitat for their spring and fall migrations (Gill and Senner 1996). Most of this habitat is located in western and southwestern Alaska, where the greater tidal ranges result in larger expanses of invertebrate-rich mudflats and sandflats. Barrow/Utqiagvik, Alaska, where Arctic support helicopter flights are expected, comprises relatively minor habitat. Nesting species in Barrow/Utqiagvik include phalaropes, sandpipers, dunlin (*Calidris alpina*), long-billed dowitchers (*Limnodromus scolopaceus*), ruddy turnstone (*Arenaria interpres*), and American golden-plovers (*Pluvialis dominica*) (Alaska Shorebird Group 2016).

During the non-breeding season, most non-marine Arctic birds migrate to other parts of the globe via a series of flyways. Flyways within or bordering the Arctic proposed action area include the East Asia/Australia flyway, the East Atlantic flyway, and the “American” Flyways: Mississippi, Atlantic, and Pacific (BirdLife International). These flyways are generally oriented north-south, although significant high-altitude migration likely occurs between and among Alaska, the Canadian High Arctic, and Siberia (Alerstam et al. 2007; Alerstam and Gudmundsson 1999a; Alerstam and Gudmundsson 1999b; Gudmundsson et al. 2002).

3.2.5.3 High-Altitude Arctic Migrants

Because of the altitudes involved in high-altitude migration, it is difficult to observe these birds directly. Rather, studies of this phenomenon rely on the use of ship-based tracking radars to infer the presence, heading, and speed of the birds. Probable flight paths are then extrapolated from this information, and these flight paths appear to overlap parts of the Arctic and Pacific Northwest proposed action areas. In some cases, radar tracks can be coupled with sightings to indicate the likely types of birds involved, although species-level identifications are generally lacking.

Alerstam and Gudmundsson (1999b) suggest shorebirds (and possibly terns and skuas) migrate from Siberia to North America in July and August, passing over the Arctic proposed action area at altitudes above one kilometer on average. Some two million birds are thought to comprise this Siberian-American migration system, and some may continue along the Pacific Flyway toward points further south (Alerstam et al. 2007). Gudmundsson et al. (2002) suggest a mass easterly migration of shorebirds occurs from the southeastern Beaufort Sea toward Nova Scotia in July and August at mean altitudes exceeding 0.6 mi (0.9 km). Although these eastbound birds may not pass over the Arctic proposed action area, some sparse westward migration was also noted, possibly consisting of loons, gulls, ducks, and jaegers.

3.2.5.4 Antarctic Proposed Action Area Overview

The presence and absence of pack ice, coupled with the Antarctic Convergence (where colder Antarctic waters sink beneath warmer sub-Antarctic waters to create a seasonally-varying zone of upwelling and productivity) are largely responsible for the broad-scale distribution of birds in the Antarctic (Ainley et al. 1984). Pack ice covers the Ross Sea (the sea overlapping with and adjacent to the proposed action area) during the austral winter, and is thought to play a larger role than the Antarctic Convergence in determining bird distributions in this area.

Ainley et al. (1984) recognizes three distinct communities of bird species in the Ross Sea. The first is comprised of high latitude, pack ice-associated species such as emperor penguins (*Aptenodytes forsteri*), Adélie penguins (*Pygoscelis adeliae*), Antarctic petrels (*Thalassoica antarctica*), snow petrels (*Pagadroma nivea*), and south polar skuas (*Catharacta maccormicki*). The second includes species associated with the cold waters and icebergs north of the pack ice, such as the southern fulmar (*Fulmarus glacialoides*) and various other fulmarine and non-fulmarine petrels. These first two communities are likely represented in the proposed action area. However, the third community includes sub-Antarctic species typically found outside of the proposed action area. Examples include albatrosses, which are associated with the Ross Sea slope as opposed to shelf (Ainley et al. 2010a).

The principal avian inhabitants of the Ross Sea (and, probably by extension, the Antarctic proposed action area) are petrels and penguins. The Ross Sea is home to about 1 million snow petrels and 5.5 million Antarctic petrels (Ainley et al. 2010a). This represents a substantial portion of the world population of Antarctic petrels, which is estimated at 10–20 million individuals (van Franeker et al. 1999). Both species of petrel breed on snow-free ridges, mountains, and peaks, most of which are mainly located hundreds of kilometers inland, but roost on icebergs grounded near the shelf break. Some 4.1 million Emperor and Adélie penguins (discussed in detail in Section 3.2.5.4.a) breed, forage, and molt throughout the Ross Sea's waters, pack ice, floes, and adjacent land. Other species that may be encountered in the Ross Sea include vagrant king penguins (*Aptenodytes patagonicus*), other petrel species, fulmars, skuas, shearwaters, albatrosses, terns, and prions (Ainley et al. 1984). Most of these are likely present in the Antarctic proposed action area as well.

Bird migration to and from Antarctica does not occur on the same scale as it does for the other proposed action areas. Thus, there are no recognized flyways above the Ross Sea (nor Antarctica in general). Nonetheless, some bird species present in the Ross Sea undertake migrations to other continents. For example, the Arctic tern (*Sterna paradisaea*) winters in the Ross Sea and travels to the Arctic to breed (Ainley et al. 1995; Norwegian Polar Institute), and the south polar skua is known to overwinter in the northern hemisphere, making use of the Atlantic and Pacific Flyways for parts of its journey (Kopp et al. 2011).

3.2.5.4.a Order Sphenisciformes (Penguins)

Emperor penguins (*Aptenodytes forsteri*) and Adélie penguins (*Pygoscelis adeliae*) comprise the vast majority of penguin species in the Ross Sea, representing 26 percent and 38 percent of the world's population, respectively, and a total of 4.1 million individuals combined (Ballard et al. 2010). In contrast, king penguins are rarely sighted in the Ross Sea (Ainley et al. 1984).

During the early austral summer (December and January), Adélie and emperor penguins are found in association with the Ross Sea marginal ice zone (i.e., the transition area between open ocean and sea ice), with very few penguins frequenting the ice-free or pack ice-covered waters on either side of this zone (Ainley et al. 2010b). They forage voraciously before molting in January and February, during which time they reside on ice floes in the waters of the eastern Ross Sea and points further east. As the austral winter sets in and days become shorter, Adélie penguins move with the increasing pack ice extent toward lower, more temperate latitudes near the Antarctic circle (Ballard et al. 2010) whereas emperor penguins remain at higher latitudes (roughly at 77° S) throughout the winter (Burns and Kooyman 2001).

Emperor penguins breed on the sea ice in the austral autumn (March to May), whereas Adélie penguins breed on land in October and November (Pinkterton et al. 2010). After breeding, parents of both species migrate to the sea to forage for their young. Watanabe et al. (2012) produced activity time budgets for foraging emperor penguins during their austral spring chick-rearing period in the Ross Sea. After traveling from the colony to the ice edge, penguins spent 30.8 percent of their time on the ice. They spent the remainder of time in the water, swimming/resting either at the surface (22.2 percent), descending/ascending (25.6 percent), or on the bottom (21.4 percent). Kooyman and Kooyman (1995) note a modal dive depth of 69–141 ft (21–40 m), with a maximum depth of 1,752 ft (534 m). Ascent and descent rates were generally between 2.2–4.5 miles per hour (mi/hr; 3.5–7.2 kilometers per hour [km/hr].

Yoda et al. (2001) produced activity time budgets of chick-rearing Adélie penguins in December and January in Adélie Land (an ice-free area west of the Ross Sea), and Lützow-Holm Bay (an ice-covered bay). The Adélie penguins spent 31.9 percent and 48.4 percent of their time diving in ice-covered and ice-free areas, respectively. Most of the remaining time was spent resting at the water surface (in ice-free areas) or standing on land (in ice-covered areas). Chappell et al. (1993) found that Adélie penguins dive to a mean depth of 85 ft (26 m). Watanuki et al. (1997) noted average dive depths of between 75 and 23 ft (23 and 7 m), with the shallower depths occurring in the presence of sea ice. Maximum dive depth was 590 ft (180 m). Dive depths are generally similar between morning and night (Chappell et al. 1993). Their swimming speed is about 4.5 mi/hr (7.2 km/hr) (Sato et al. 2002).

3.2.5.5 Pacific Northwest Proposed Action Area Overview

The nutrient-rich waters of the Pacific Coast result in an abundance and diversity of seabird species (Kaplan et al. 2010), with roughly as many species present in the Pacific Northwest proposed action area as in the Arctic and Antarctic areas combined. Commercial fishing vessels also serve to aggregate birds offshore Washington, particularly along the shelf where shrimp trawling and dragging takes place (Wahl 1975). Wahl et al. (1993) estimate some 38 local species and 17 visiting species occur over the continental shelf offshore Washington and Vancouver Island (Wahl et al. 1993). Furthermore, the proposed action area is near several "hotspots" of seabird abundance, as identified by the Audubon Society (Sydeman et al. 2012).

The varied ocean circulation and topography of the Pacific Northwest drives seabird distributions. Here, seabirds tend to aggregate around wind-driven upwelling zones, seasonal prey concentrations, and sea surface fronts (Wahl et al. 1993). The highest numbers have been observed in conjunction with prey concentrations above undersea canyons along the shelf break (Hay 1992). Such concentrations are typically comprised of shrimp-like euphasiids (Burger 2003). Productivity, prey abundance, and thus seabird density typically decline with depth (Alan et al. 2004; Wahl et al. 1993). Seabirds of the Pacific Northwest typically spend the fall and winter foraging offshore, returning to land in the spring and summer to breed and raise their young, often in large colonies (Kaplan et al. 2010).

Wahl et al. (1993) divide variations in seabird species composition in the British Columbia-Washington offshore region into six “seasons.” In early spring, bird populations are mainly comprised of fulmars, gulls, kittiwakes, murres, guillemots, murrelets, and auklets. In late spring, they are joined by shearwaters, jaegers, terns, and more gulls. Summer represents a decline in species richness, during which time storm-petrels, cormorants, gulls, and alcids nest on offshore islands and rocks along the coast of Vancouver Island and northern Washington; nesting populations on the southern coast of Washington are made up almost entirely of double-crested cormorants (*Phalacrocorax auritus*), gulls, and caspian terns (*Sterna caspia*). Some species travel from the southern hemisphere to forage in the waters offshore Washington state during summer, such as the sooty shearwater (*Puffinus griseus*), which breeds in New Zealand (Sydeman et al. 2012; Washington State Department of Ecology 2017). Abundance and diversity peak in early fall (July–August) as recently hatched birds take flight and migrants arrive in the region from inland nesting areas, Oregon, and California. These high numbers persist into late fall but drop in winter as a number of species move to sheltered, inland waters. Northern fulmars, gulls, and alcids make up the majority of winter bird population.

The Pacific Flyway overlaps the Pacific Northwest proposed action area. Some species that winter in the Pacific Northwest use it to migrate from breeding sites further north, whereas other species that breed in the Pacific Northwest use it to migrate to wintering sites scattered throughout much of the globe (Gill and Senner 1996). Not all species that use the Pacific Northwest Flyway travel over the proposed action area. For example, Western sandpipers (*Calidris mauri*) use a "hopping" strategy, which does not take them offshore, and their migratory pathways are constrained to coastal intertidal wetlands along the Pacific coast (Iverson et al. 1996). Both seabirds (e.g., red phalarope [*Phalaropus fulicarius*], Arctic tern, and pomarine skua [*Stercorarius pomarinus*]) and shorebirds use the Pacific Flyway (Alerstam et al. 2007).

3.2.5.6 ESA-Listed Seabird Species

There are four species of birds listed under the ESA that may be present in the Arctic and Pacific Northwest proposed action areas (Table 3-8). Some of these are true seabirds that spend the majority of their lives at sea (e.g., short-tailed albatross [*Diomedea albatrus*]) whereas others only forage offshore for a limited amount of time (e.g., Steller’s eider [*Polysticta stelleri*]). They are described in detail in the following sections.

Table 3-8. ESA-Listed Seabirds within the Proposed Action Areas

Species	Proposed Action Area	Status	Type of Bird
Marbled murrelet *(Brachyramphus marmoratus)*	Likely in the Pacific Northwest	Threatened	Seabird
Short-tailed albatross *(Diomedea albatrus)*	Likely in the Arctic, Extralimital in the Pacific Northwest	Endangered	Seabird
Steller's eider *(Polysticta stelleri)*	Likely in the Arctic	Threatened	Waterfowl/Sea Duck
Spectacled eider *(Somateria fischeri)*	Likely in the Arctic	Threatened	Waterfowl/Sea Duck

3.2.5.6.a Marbled Murrelet

Marbled murrelets (*Brachyramphus marmoratus*) that occur in California, Oregon, and Washington are listed as threatened under the ESA (53 FR 40479; October 1, 1992) (USFWS 1992). Marbled murrelets that occur in Alaska are not protected under the ESA and are not discussed below. Critical habitat was designated in 1996, revised in 2011, and finalized in 2016 as mature and old-growth forest nesting habitat near the coast (but not including marine areas) in Washington, Oregon, and California (81 FR 51348; August 4, 2016) (U.S. Fish and Wildlife Service 2016; USFWS 2009a). This critical habitat is not within any proposed action area and is not discussed further in this document. A recovery plan for the marbled murrelet was published in 1997 (USFWS 1997). Marbled murrelets not protected under the ESA may be found in the Arctic proposed action area year-round. While some sighting records exist for ESA-listed marbled murrelets in the Pacific Northwest proposed action area, the proposed action area is further offshore than the typical range of occurrence for the marbled murrelet.

Marbled murrelets are typically observed in protected coastal waters within 3 mi (5 km) of the shore and in waters less than 197 ft (60 m) deep (Ainley et al. 1995; Day and Nigro 2000; International Union for the Conservation of Nature 2016). Their geographic range in Washington includes the southern Salish Sea and the outer coast (Desimone 2016). Although there are records of occurrence near the Pacific Northwest proposed action area (Piatt and Drew 2015), these likely represent isolated instances as marbled murrelets typically forage within 1.2 mi (2 km) of shore in Washington waters (Strachan et al. 1995); marbled murrelets have been documented foraging up to 186 mi (300 km) from shore in waters 1,312 ft (400 m) deep (Burger 2002; Piatt and Naslund 1995; Strachan et al. 1995). Highest densities during the breeding season are found on the northern outer coast, northern Puget Sound, and the Strait of Juan de Fuca (Miller et al. 2012). During April to mid-September, breeding murrelets make daily trips from marine foraging areas to inland nest sites. These nest sites do not overlap with the proposed action area; nest locations in Washington are in coastal forests up to 36.5 mi (59 km) from the nearest marine waters (Desimone 2016).

During the breeding season, the at-sea distribution of murrelets in Washington appears to be more strongly related to the proximity of suitable inland nesting habitats as opposed to suitable marine foraging habitat (Raphael et al. 2015). In winter, some marbled murrelets are thought to move south on a regional scale (e.g., from British Columbia to Puget Sound), although others maintain an association with their inland nesting habitats (Beauchamp et al. 1999; Strachan et al. 1995). In Washington, some individuals appear to use multiple marine regions (e.g., the outer coast, Puget Sound, Strait of Juan de Fuca) in a single year (Desimone 2016). In general, murrelets shift their foraging locations from exposed outer coasts into protected waters during winter.

Murrelets typically aggregate in small, well-defined foraging areas where prey species concentrate (Nelson 1997). They feed opportunistically on small fish (e.g., sand lance, anchovy, herring, capelin, and smelt) and invertebrates (USFWS 1997, 2005a). They typically capture prey within 164 ft (50 m) of the surface (Thoresen 1989), but have been documented foraging throughout the water column, including the bottom (Sanger 1987). The murrelet forages by pursuit diving in relatively shallow waters, usually between 6 and 24 ft (20 and 80 m) in depth, using its wings for underwater propulsion. Foraging dive times average about 16 seconds. Murrelets generally forage during the day, and are most active in the morning and late afternoon hours, but some foraging also occurs at night (Ralph and Miller 1995). The majority of birds are found as pairs or as singles in a band about 91 to 610 ft (300 to 2,000 m) from shore. Typically, marbled murrelets are foraging when venturing this distance offshore.

Marbled murrelets have been recorded with average flight speeds of 63 mi/hr (101 km/hr) (Harper et al. 2004) and a maximum speed of 98 mi/hr (158 km/hr) (Nelson 1997). Stumpf et al. (2011) recorded marbled murrelets traveling at an average flight height of 830 ft (253 m) for seaward flights.

3.2.5.6.b Short-tailed Albatross

The short-tailed albatross (*Phoebastria albatrus*) is listed as endangered under the ESA throughout its range (65 FR 46643–46654; July 31, 2000). Currently, no critical habitat has been designated for this species (Piatt et al. 2006; USFWS 2000). A recovery plan for the short-tailed albatross was published in 2005 (USFWS 2005b).

Short-tailed albatrosses move seasonally around the North Pacific Ocean (International Union for the Conservation of Nature 2016). During the breeding season, short-tailed albatrosses prefer to nest on isolated, windswept, offshore islands protected from human access (USFWS 2000). Almost all of these birds nest on two uninhabited islands outside of the proposed action areas: Torishima Island (78 percent of breeding pairs) and Minami-Kojima (22 percent of breeding pairs) (USFWS 2014).

Occurrence in the Bering Sea of Alaska is common, as short-tailed albatrosses feed along the shelf break and the Aleutian chain (USFWS 2005b). Most commonly, these birds are pelagic, occurring at the edges of the basins in the Bering Sea. They tend to concentrate along the edge of the continental shelf and upwelling zones (NatureServe 2004). The northernmost extent of the range of the short-tailed albatross is the Bering Strait, and the southernmost extent of their range, along the coast of North America, is northern California (USFWS 2005b).

Of the 242 short-tailed albatross sightings recorded during International Pacific Halibut Commission stock assessment surveys from 2002 to 2013, none were in waters off of Washington (Geernaert 2013). In the vicinity of the Pacific Northwest proposed action area, only a single sighting record exists (Piatt and Drew 2015). In 1970, the sighting of a single short-tailed albatross offshore Washington was considered worthy of publication (Wahl 1970). Short-tailed albatrosses occur only as migrants in Washington and do not nest in the state (WDFW 2015). Occurrence of the short-tailed albatross in the Pacific Northwest proposed action area would be extralimital and considered a very rare event.

Short-tailed albatrosses are surface feeders and scavengers, foraging frequently in sight of land and more inshore than other North Pacific albatrosses. Short-tailed albatrosses feed at the surface and their diet consists of shrimp, squid, and fish (USFWS 2005b).

Although flight speed and altitude were not available for short-tailed albatrosses, information concerning other albatross species is available. When traveling over open ocean habitats, these species were recorded traveling at average speeds between 25 and 30 mi/hr (40 and 48 km/hr) (Alerstam et al. 1993). Various species of albatross were observed flying at altitudes of 13 to 26 ft (4 to 8 m) in coastal areas (Pennycuick 1982).

3.2.5.6.c Steller's Eider

The Alaska breeding population of Steller's eider (*Polysticta stelleri*) is listed as threatened under the ESA (56 FR 19073; June 11, 1997). Critical habitat is designated in five units in Alaska, including Kuskokwim Shoals, the Seal Islands, Nelson Lagoon, Izembek Lagoon on the north side of the Alaska Peninsula, and the Yukon-Kuskokwim Delta (66 FR 8850; 02 February 2001). Critical habitat for this species is located entirely within the Arctic proposed action area (Figure 3-7). A recovery plan for the Steller's eider was published in 2002 (USFWS 2002). Steller's eider may be encountered within the Arctic proposed action area year-round, typically near the sea surface.

Steller's eider are mostly described as a near-shore species; however, they have been detected over 18.6 mi (30 km) from shore in Kuskokwim Bay (U.S. Fish and Wildlife Service 2001) and frequently use waters up to 98 ft (30 m) deep in winter, possibly for resting and/or foraging on zooplankton (Martin et al. 2015). Usually, wintering Steller's eiders are found within 0.25 mi (400 m) of shore except where shallows extend farther offshore in bays and lagoons or near reefs (USFWS 2002). The Kuskokwim bay portion of the critical habitat extends up to about 25 miles seaward (Figure 3-7).

Currently, three breeding populations of Steller's eiders are recognized worldwide. Two of these populations breed in Russia, and the other breeds along the Arctic coast, particularly near Barrow/Utqiagvik, in the spring and summer, (Kertell 1991). Steller's eiders also breed in western Alaska on the Yukon-Kuskoskwim Delta, but only in small numbers (Alaska Department of Fish and Game 2017j). Steller's eiders nest outside of the Arctic proposed action area in tundra habitats generally 12 to 19 mi (20 to 30 km) inland from the coast, but may use nesting locations as far inland as 62 to 93 mi (100 to 150 km) (Fredrickson 2001).

During their southward fall migration, Steller's eiders inhabit shallow seas near the coast and shallow coastal lagoons (Fredrickson 2001). Most molt in a few lagoons on the north side of the Alaska Peninsula and along the western Alaska coast (U.S. Fish and Wildlife Service 2011). Some remain in these areas throughout winter, while others disperse to the coastal waters of the eastern Aleutian Islands, southern Alaska Peninsula, Kodiak Archipelago, and southern Cook Inlet, intermixing with the far more abundant (and non-listed) Russian Pacific population. In the spring, Steller's eiders return to their breeding grounds, generally moving east and north in large flocks along the coast, although birds may take shortcuts across Bristol Bay and Kotzebue Sound (Minerals Management Service 2006). They migrate in long lines only a few feet above the water (Alaska Department of Fish and Game 2017j).

In marine environments, Steller's eiders prey upon mollusks, crustaceans, polychaete worms, echinoderms, small fish, gephyrean worms, gastropods, and brachiopods (Bustnes et al. 2000; Petersen 1981). They forage in coastal lagoons and inlets, around reefs, and in marine bays. They are often associated with sea lettuce (*Ulva* spp.), eelgrass (*Zostera* spp.), and brown seaweed (*Fucus* spp.) where small mollusks, gastropods, and crustaceans are abundant (Fredrickson 2001). They typically dive for their prey in water 16 to 33 ft (5 to 10 m) deep (Fredrickson 2001). At the Izembek Lagoon within the Aleutian Basin, time spent foraging accounted for 60.7 percent of their diurnal activity in the winter (Fredrickson 2001). Steller's eiders spend more time foraging in the winter (76.1 percent) than in the spring (54.5 percent), but they forage mainly in Izembek Lagoon and Cold Bay within the Aleutian Basin during both seasons (Fredrickson 2001). Although flight speed and altitude were not available for Steller’s eiders, information on eiders in general suggests average flight altitudes of 20 ft (6 m) and average flight speeds of 47.9 mi/hr (172 km/hr) offshore Alaska (Day et al. 2005).

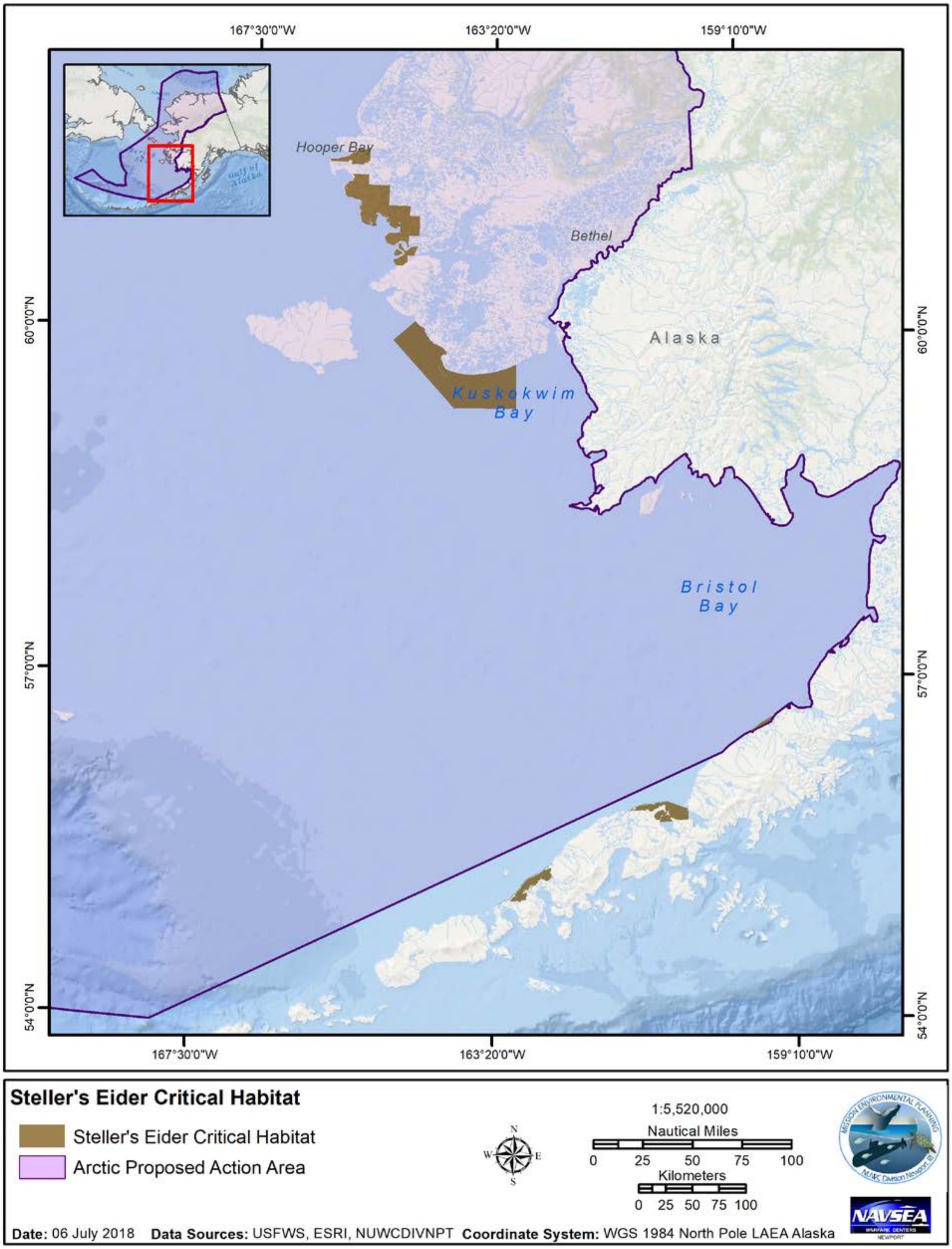


Figure 3-7. Designated Critical Habitat for the Steller's Eider

3.2.5.6.d Spectacled Eider

The spectacled eider (*Somateria fischeri*) is listed as threatened under the ESA throughout its range (58 FR 27474; May 10, 1993). In 2001, the United States Fish and Wildlife Service (USFWS) designated critical habitat (Figure 3-8) for spectacled eider (66 FR 9146; February 6, 2001). Critical habitat is designated in the Yukon-Kuskokwim Delta, Norton Sound, Ledyard Bay, and the Bering Sea; therefore, critical habitat is located within the Arctic proposed action area (Figure 3-8). A recovery plan for the spectacled eider was published in 1996 (USFWS 1996). Spectacled eiders may be encountered in the Arctic proposed action area year-round. In the offshore environment, they are most likely to be encountered southwest of St. Lawrence Island in winter.

Spectacled eiders spend a significant portion of their life in the offshore marine environment. They have been recorded up to 128 mi (206 km) offshore (Petersen et al. 1999). In the winter, spectacled eiders congregate in the Bering Sea around open leads (polynyas) and holes in pack ice or over pelagic habitats with water depths greater than 262 ft (80 m) (Grebmeier and Cooper 1995). They are not restricted to polynyas, however, and may use areas with greater than 60 percent ice coverage (Petersen et al. 1999). They are typically found south of 64° N, north of 61° N, west of 168° W, and east of 175° W. Their core wintering area in most years is restricted to a relatively small area (about 31 by 47 mi [50 by 75 km]) centered at about 62° N 173° W (southwest of St. Lawrence Island) (Petersen et al. 1995; Petersen et al. 1999). Rarely, individuals or small flocks of spectacled eiders inhabit Izembek Lagoon, Kodiak Island, and Kachemak Bay in the winter, but the vast majority of the population inhabit the Bering Sea (Dau and Kistchinski 1977). During their spring and fall migration periods, spectacled eiders inhabit the off-shore regions of the Arctic, Chukchi, and Bering Seas (Petersen et al. 1995; Petersen et al. 1999).

During the breeding season, most spectacled eiders in North America breed in western Alaska at the Yukon-Kuskowim Delta, from Nelson Island to the Askinuk Mountains, near the Bering Sea. In northern Alaska, they breed in wetlands along the coasts of the Beaufort and Chukchi seas from Demarcation Point to Barrow/Utqiagvik and from Barrow/Utqiagvik to Wainwright during the summer months. Spectacled eiders nest on small islands and peninsulas, along the shorelines of ponds, and in dry areas of wet meadows (Anderson et al. 1999; Dau 1976; Kistchinski and Flint 1974; Pearce et al. 1998; Petersen et al. 2000). While living inland during the breeding season, spectacled eiders prey upon insects and insect larvae, seeds, and plant materials along the edges and bottoms of freshwater ponds (Kistchinski and Flint 1974; Petersen et al. 2000) by feeding at the surface, upending, dabbling, or diving for their prey (Kistchinski and Flint 1974; Petersen et al. 2000). During the non-breeding seasons, they forage in marine habitats and mostly consume benthic invertebrates in waters greater than 262 ft (80 m) deep (Petersen et al. 1998) by diving for their prey (Petersen et al. 2000).

Females migrate to molting areas in July if unsuccessful at nesting, or in August/September if successful (Petersen et al. 1999). When migrating between nesting and molting areas, spectacled eiders travel along the coast up to 37 mi (60 km) offshore (Petersen et al. 1999). Molting flocks gather in relatively shallow coastal water, usually less than 118 ft (36 m) deep. Late summer and fall molting areas have been identified in eastern Norton Sound (northern Bering Sea) and Ledyard Bay (eastern Chukchi Sea) in Alaska (U.S. Fish and Wildlife Service 2003). Eiders are particularly vulnerable during the fall molting period, when they are unable to fly for approximately three weeks between June and October (Petersen et al. 1999). Although flight speed and altitude were not available for spectacled eiders, information on eiders in general suggests average flight altitudes of 20 ft (6 m) and average flight speeds of 47.9 mi/hr (172 km/hr) offshore Alaska (Day et al. 2005).

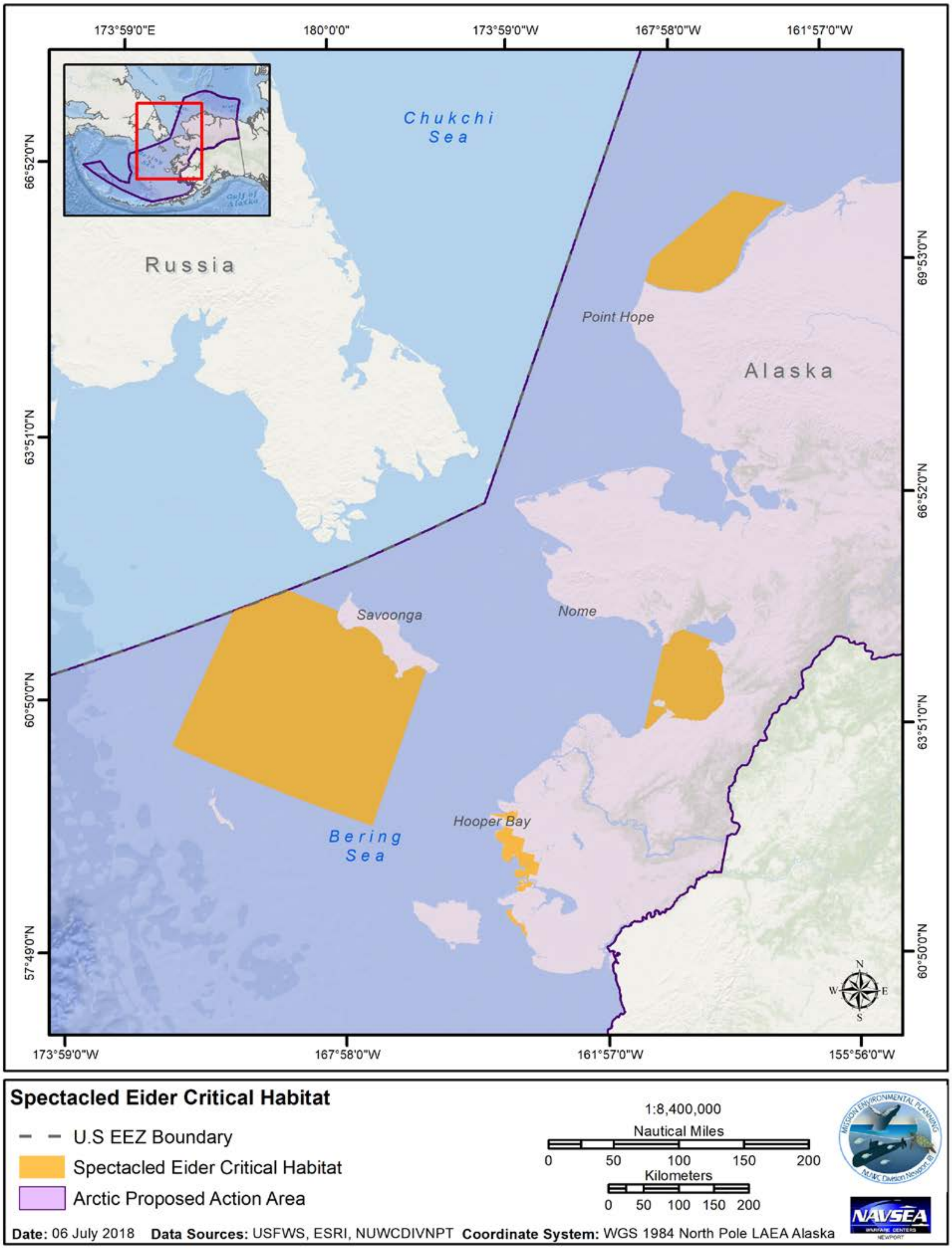


Figure 3-8. Designated Critical Habitat for the Spectacled Eider

3.2.5.7 Seabird and Shorebird Hearing

3.2.5.7.a In Air

Dooling (2002) provided a complete summary of what is known about basic in-air hearing capabilities of a variety of bird species. Birds hear best in air at frequencies between 1 and 5 kHz, with absolute sensitivity often approaching 0 to 10 dB re 20 micropascals (µPa) at the most sensitive frequency, which usually is in the region of 2 to 3 kHz. A study of diving birds (ducks, gannets, and loons) showed best in-air hearing between 1 and 3 kHz (Crowell et al. 2015). On average, the spectral limit of "auditory space" available for a bird to vocally communicate in air extends from approximately 0.5 to 6 kHz (Dooling 2002). Dooling (2002) and Beason (2004) also noted that birds do not hear well at either high or low frequencies when compared to most mammals, and do not hear at frequencies greater than 15 kHz. The only study of hearing in a penguin indicated best sensitivity between 0.6 and 4 kHz in air (Wever et al. 1969).

Studies have examined hearing loss and recovery in only a few species of birds, and none studied hearing loss in seabirds (Hashino et al. 1988; Ryals et al. 1999; Ryals et al. 1995; Saunders and Dooling 1974). A bird may experience PTS if exposed to a continuous Sound Pressure Level (SPL) over 110 A-weighted decibels (dBA) re 20 µPa in air. Continuous noise exposure at levels above 90 – 95 dBA re 20 µPa can cause TTS (Dooling and Therrien 2012), while physical damage to birds' ears occurs with short-duration but very loud sounds (>140 dBA re 20 µPa for a single blast or 125 dBA re 20 µPa for multiple blasts) (Dooling et al. 2006). The potential effects from in air acoustic noise from the Proposed Action includes: TTS, auditory system damage and PTS, masking, and other physiological and behavioral responses.

3.2.5.7.b In Water

Diving birds may not hear well under water because of adaptations to protect their ears from pressure changes during diving (Dooling and Therrien 2012). Currently, there is limited underwater auditory threshold data. The long-tailed duck (*Clangula hyemalis*) was recorded responding to underwater sound stimuli with frequencies between 0.5 and 2.86 kHz at underwater stimuli greater than 117 dB re 1 µPa @ 1 m (Therrien 2014). The most recent study on the underwater hearing range of a diving bird was on great cormorants (*Phalacrocorax carbo*). Hansen et al. (2017) found that great cormorants can hear between 1 and 4 kHz underwater. Common murres (*Uria aalge*) avoided gill nets with acoustic deterrent devices emitting a 1.5 kHz tone at 120 dB re 1µPa @ 1 m (Melvin et al. 1999). Seabirds spend a limited amount of time underwater, and Dooling and Therrien (2012) speculate that hearing may not serve a useful function, such as locating prey or avoiding predators, for birds underwater (although research in this area is lacking). The masking effects to seabirds are unable to be estimated due to variable species communication styles, behaviors, and hearing capabilities (Dooling and Popper 2007). Since ESA-listed seabirds spend a limited amount of time (ranging from dives of four to 58 seconds (Hawkins et al. 2000; Heath et al. 2007) underwater, exposure to underwater noise would not be prolonged and therefore any seabirds in the area would not be expected to overlap with the proposed activities expected to produce underwater noise for an extended period of time. The potential effects from in-water acoustic noise from the Proposed Action includes: TTS, auditory system damage and PTS, masking, and other physiological and behavioral responses. There are currently no criteria for acoustic thresholds to evaluate potential impacts to birds.

3.2.6 Sea Turtles

Since 1977, NMFS and the USFWS have shared jurisdiction over the recovery and conservation of sea turtles, all of which are listed as endangered or threatened under the ESA. Six species of sea turtle are found in U.S. waters: the green sea turtle (*Chelonia midas*), hawksbill turtle (*Eretmochelys imbricata*), Kemp's ridley turtle (*Lepidochelys kempii*), leatherback turtle (*Dermochelys coriacea*), loggerhead turtle (*Caretta caretta*), and the olive ridley turtle (*Lepidochelys olivacea*). Recovery plans were published for all six sea turtles in 1998 (NMFS and USFWS 1998). Within the proposed action areas, sea turtles are only expected to occur in the Pacific Northwest proposed action area, although leatherback sea turtles are considered extralimital in the Arctic proposed action area. All other sea turtle species, which may be encountered outside of the proposed action areas, are discussed in Appendix A, as species evaluated for "Transit Only." The only ESA-listed species within the proposed action areas is the leatherback sea turtle, described in Section 3.2.6.3. General information on sea turtle hearing is discussed in Section 3.2.6.4.

Sea turtles are highly migratory, ranging throughout vast expanses of the world's oceans. Because most are ectothermic, they must live in warm waters or risk cold stunning, which entails decreased circulation, lethargy, shock, and possibly death. Leatherbacks are the exception, and are more likely to be found in colder waters at higher latitudes because of their unique ability to maintain an internal body temperature higher than that of their environment (Hodge and Wing 2000). Habitat use varies among species and within the life stages of individual species, correlating primarily with the distribution of preferred food sources, as well as the locations of nesting beaches.

Little information is available about a sea turtle's life history after hatching. Open-ocean juveniles spend perhaps up to around 10 years drifting, foraging, and developing (Luschi et al. 2003). After this period, most species of sea turtles are found in more coastal habitats, where they complete their development. The leatherback sea turtle however, is known to continue to travel long-distances throughout its lifetime (Hughes et al. 1998). Although sea turtles live most of their lives in the ocean, adult females must return to beaches on land to lay their eggs. Sea turtles exhibit natal site fidelity, and in the most well-studied cases, these habitats are likely to be closer to the nesting beach where the hatchling emerged than to the pelagic nursery habitat (Luschi et al. 2003). They often migrate long distances between feeding grounds and nesting beaches

3.2.6.1 Arctic Proposed Action Area Overview

Although sea turtles are absent from polar waters, they have been sighted in Alaska on rare occasions. Statewide, including areas in southeast Alaska outside of the Arctic proposed action area, from 1960 to 2007, there have been two reported sightings of loggerhead sea turtles, three reported sightings of olive ridley sea turtles, 15 reported sightings of green sea turtles, and 19 reported sightings of leatherback sea turtles (Alaska Department of Fish and Game 2017d, 2017f, 2017g, 2017h). Prior to 1993, sightings were mostly of live leatherbacks; however, since that time, most observations of sea turtles in Alaska have only been of green sea turtle carcasses (Hodge and Rabe 2008). While olive ridley sea turtles and loggerhead sea turtles were once rare visitors to the Gulf of Alaska, they have not been seen in many years either due to changes in oceanographic conditions, turtle populations and distribution, or climate change.

Only the range of the leatherback sea turtle extends into the Arctic proposed action area (specifically, the southern Bering Sea). All other sightings are limited to the Alaskan Gulf Coast. Based on records from 1960–1998, Hodge and Wing (2000) identify July through October as “turtle season” in Alaska. Hodge and Wing suggest that Alaskan waters may provide marginal habitat for the cold-tolerant leatherback sea turtle, but are beyond the tolerable range of the other three species. Sea turtles probably reach Alaska by way of the warm Japan Current and North Pacific Current (Hodge and Rabe 2008).

3.2.6.2 Pacific Northwest Proposed Action Area Overview

Three species of sea turtles have been observed off Washington State: green sea turtles, leatherback sea turtles, and loggerhead sea turtles (Washington State Department of Ecology 2017). Leatherback and loggerhead sea turtles are listed as endangered under the ESA (leatherback sea turtle: 35 FR 8491; June 2, 1970 and loggerhead sea turtle: 76 FR 58868; September 22, 2011), while green sea turtles are listed as threatened (81 FR 20057; May 6, 2016). These species nest in tropical regions; no nesting occurs within the Pacific Northwest proposed action area or on nearby shores of Washington State. The leatherback sea turtle is the only sea turtle found regularly in Washington waters, where it is also listed as endangered by the state. While loggerhead sea turtles and green sea turtles could be observed off Washington State (see below), the likelihood that they would overlap with the Pacific Northwest proposed action area during vessel functionality testing is low; therefore, they are only analyzed for potential effects from vessel movement while the vessel is in transit (Appendix A).

Foraging leatherbacks in Washington belong to the western Pacific population (Dutton et al. 2000), which nests in Indonesia, the Solomon Islands, Papua New Guinea, and Vanuatu (Sato 2016a). The migration from their nesting grounds to their foraging grounds represents a 10–12 month journey (Benson et al. 2011). In Washington, their range spans from the entire outer coast toward pelagic waters. Sighting and stranding records in Washington occur from May through October, with 78 total reports from 1975 to 2013 (Sato 2016a).Their abundance is highest in summer and fall, especially in areas where oceanographic conditions (e.g., the Columbia River plume) aggregate jellyfish (Washington State Department of Ecology 2017). This plume can extend to the north and south of the Columbia River mouth during this time, but it does not appear to overlap with the Pacific Northwest proposed action area, based on recent studies (Hickey et al. 2005; Thomas and Weatherbee 2006). Similarly, the proposed action area is farther offshore and does not overlap with critical habitat for the leatherback sea turtle (Figure 3-9), and if anything, the actual activity footprint would be smaller than that of the entire proposed action area.

In contrast to leatherback sea turtles, sightings of loggerhead turtles (North Pacific DPS) and green sea turtles (East Pacific DPS) are much more rarely recorded off the Washington coast (Washington State Department of Ecology 2017). These observations are usually of stranded individuals. To date, 28 green sea turtles and 8 loggerhead sea turtles have been found along the outer of coast of Washington since 1950 and 1980, respectively (Sato 2016b). Washington is located north of the green sea turtle’s geographic range, and turtles found here are thought to have been swept northward from southern California by ocean currents. Most appear to have died from hypothermia or related conditions (Sato 2016b). Green sea turtles in Washington are members of the East Pacific DPS, which is thought to nest on beaches in Mexico (Sato 2016b). Loggerhead sea turtles in Washington are members of the North Pacific DPS, which nest in Japan (Bowen et al. 1995). Both species are considered extralimital to the Pacific Northwest proposed action area, and are therefore not discussed further.

3.2.6.3 ESA-Listed Sea Turtles

3.2.6.3.a Leatherback Sea Turtle

The leatherback sea turtle (*Dermochelys coriacea*) is listed as endangered under the ESA (35 FR 8491; June 2, 1970). There are seven recognized subpopulations of leatherback sea turtles that very widely in size, range, and population trend, but only the western Pacific leatherback subpopulation is found in the proposed action area. NMFS published a recovery plan for the western Pacific subpopulation in 1998 (NMFS and USFWS 1998). Critical habitat for leatherback turtles has been designated on the West Coast of California, Oregon, and Washington (77 FR 4170; January 26, 2012) (NMFS 2012c). The Washington portion of the critical habitat is the closest to the Pacific Northwest proposed action area, but the proposed action area is farther offshore and does not overlap with designated leatherback sea turtle critical habitat (Figure 3-9). Leatherback sea turtles may occur in the Pacific Northwest proposed action area. They may rarely occur in the southernmost portion of the Arctic proposed action area, but they are considered extralimital.

Leatherback turtles are commonly known as pelagic animals, but they also forage in coastal waters (National Marine Fisheries Service 2016a). The leatherback turtle is the most widely distributed of all sea turtles, foraging in temperate and subpolar regions of all oceans, and migrating to tropical nesting beaches (NMFS and USFWS 1992). Leatherback turtles are highly migratory, exploiting convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters (Eckert 1999). In the eastern North Pacific Ocean, leatherback turtles are broadly distributed from the tropics to as far north as Alaska (Hodge and Wing 2000). In Washington, leatherback sea turtles range from the entire outer coast toward pelagic waters. Abundance is highest in summer and fall, especially within the Columbia River plume (Washington State Department of Ecology 2017), which may overlap with the southeastern extent of the Pacific Northwest proposed action area (Hickey et al. 2005; Thomas and Weatherbee 2006).

Total global abundance of leatherback sea turtles is estimated at 54,262 nests (Wallace et al. 2013). Wallace et al. (2013) reported that the western Pacific leatherback sea turtle subpopulation has declined by 83 percent over the past three generations (roughly 100 years), mainly due to human exploitation, low hatching success, and fisheries bycatch. Sighting and stranding records in Washington occur from May through October, which is likely correlated with prey availability with 78 total reports from 1975 to 2013 (Sato 2016a), likely indicating a peak in presence in the Pacific Northwest proposed action area. The limited number of aerial surveys and incidental reports off of Washington cannot provide an accurate population estimate for this specific area; however, based on the strong decline in the western Pacific nesting population, the number of leatherbacks in Washington is likely also declining (Sato 2016a).

Primary prey includes salps and jellyfish, which leatherback sea turtles eat with tooth-like cusps and sharp-edged jaws adapted for feeding on soft-bodied animals (National Marine Fisheries Service 2016a). Off of Washington, foraging peaks during the summer and fall when large aggregations of jellyfish arrive, particularly brown sea nettles (*Chrysaora fuscescens*) and moon jellies (*Aurelia labiata*) (Sato 2016a). They also feed on other soft-bodied organisms (e.g., tunicates, cephalopods).

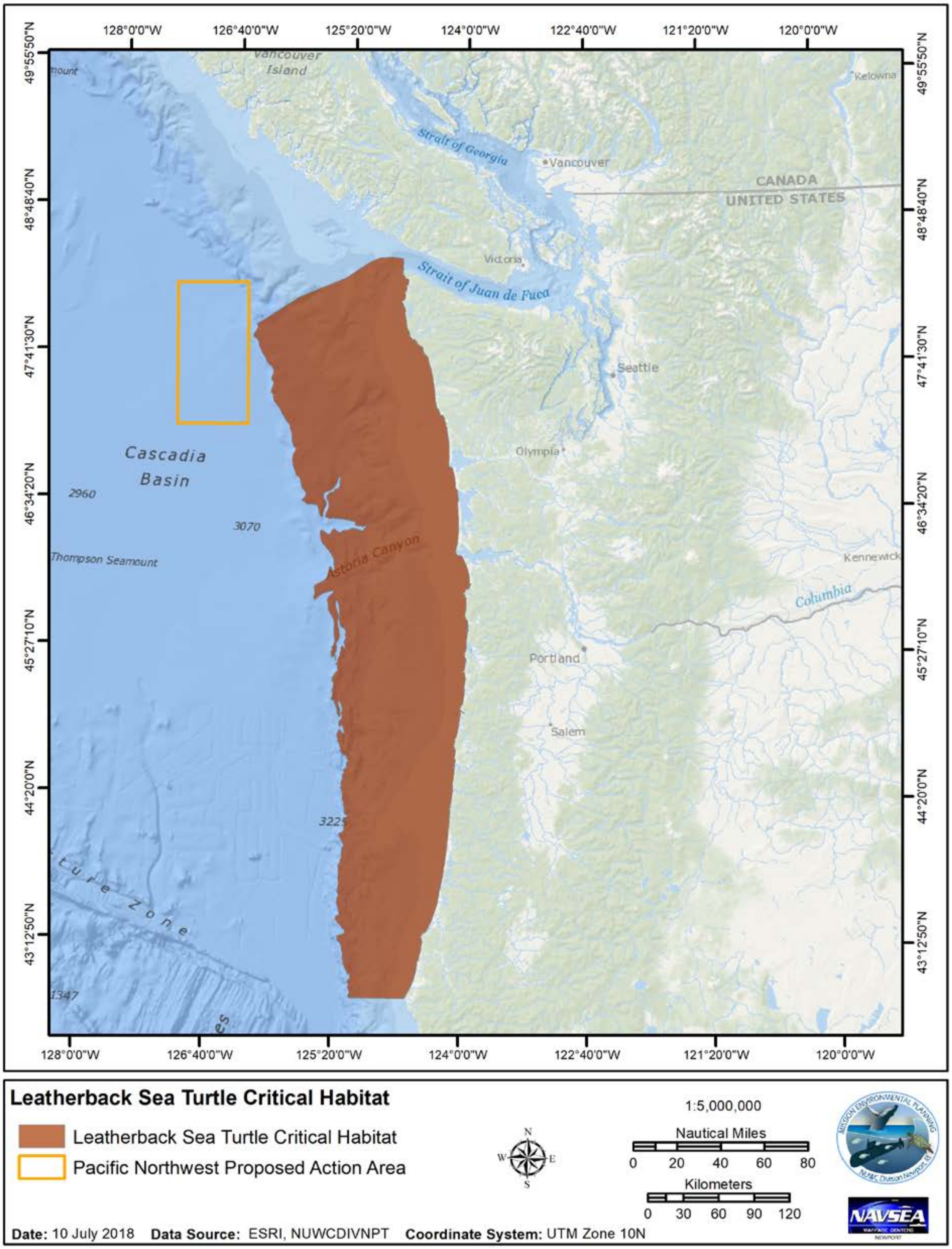


Figure 3-9. Designated Critical Habitat for the Leatherback Sea Turtle and Pacific Northwest Proposed Action Area

3.2.6.4 Sea Turtle Hearing

The auditory system of the sea turtle appears to work via water and bone conduction, with lower-frequency sound conducted through skull and shell, and does not appear to function well for hearing in air (Lenhardt et al. 1983; Lenhardt et al. 1985). Sea turtles do not have external ears or ear canals to channel sound to the middle ear, nor do they have a specialized eardrum. Instead, fibrous and fatty tissue layers on the side of the head may be the sound-receiving membrane in the sea turtle, a function similar to that of the eardrum in mammals, or may serve to release energy received via bone conduction (Lenhardt et al. 1983). Sound is transmitted to the middle ear, where sound waves cause movement of cartilaginous and bony structures that interact with the inner ear (Ridgway et al. 1969). Unlike mammals, the cochlea of the sea turtle is not elongated and coiled, and likely does not respond well to high frequencies, a hypothesis supported by a limited amount of information on sea turtle auditory sensitivity (Bartol 1994; Ridgway et al. 1969). Investigations suggest that sea turtle auditory sensitivity is limited to low-frequency bandwidths, such as the sound of waves breaking on a beach. The role of underwater low-frequency hearing in sea turtles is unclear. Sea turtles may use acoustic signals from their environment as guideposts during migration and as cues to identify their natal beaches (Lenhardt et al. 1983), but they appear to rely on other non-acoustic cues for navigation, such as magnetic fields (Lohmann and Lohmann 1996) and light (Avens and Lohmann 2003). Additionally, they are not known to produce sounds underwater for communication.

Sea turtles typically hear low frequencies from 30 to 2,000 Hz, with a range of maximum sensitivity between 100 and 800 Hz (Bartol 1994; Bartol and Ketten 2006; Lenhardt 2002; Ridgway et al. 1969). Research of leatherback sea turtle hatchlings using auditory evoked potentials showed the turtles respond to tonal signals between 50 and 1,200 Hz in water (maximum sensitivity 100 to 400 Hz) (84 dB re: 1 µPa-rms at 300 Hz) (Piniak et al. 2012).

3.2.7 Marine Mammals

Cetaceans (suborder Mysticeti and Odontoceti) and carnivores (including suborder Pinnipedia) may occur in the proposed action areas. In the United States, all marine mammals are protected under the MMPA, and some are offered additional protection under the ESA. NMFS maintains jurisdiction over whales, dolphins, porpoises, seals, and sea lions. The USFWS maintains jurisdiction over certain other marine mammal species, including walruses (*Odobenus rosmarus)*, polar bears (*Ursus maritimus*), dugongs (*Dugong dugon)*, sea otters (*Enhydra lutris*), and manatees (*Trichechus manatus*). This document covers all marine mammals under both NMFS' and the USFWS' jurisdiction, as well as marine mammals that are protected by the Antarctic Treaty Systems (seals) and the International Convention for the Regulation of Whaling. ESA-listed marine mammals are discussed in Section 3.2.7.4. Any non-ESA listed species, including a non-ESA listed stock or DPS of an ESA-listed marine mammal are included in Section 3.2.7.5. Marine mammals whose distribution overlaps with probable transiting routes, but do not fall under any of the above categories of marine mammals, are discussed only in Appendix A, but the discussions under Section 4.1.3 (Vessel Noise) and Section 4.2.1 (Vessel Movement) would be applicable for analysis. Marine mammals are expected in all proposed action areas. General information on marine mammal hearing and vocalization is discussed is discussed in Section 3.2.7.6. This PEIS also presents information, when applicable, regarding subsistence hunting and whaling.

Several terms are used to describe different types of marine mammal distribution. Animals with a cosmopolitan distribution are those that are found all over the world, like many of the great whales. Circumpolar refers to a distribution in high latitudes around one of the poles. Marine mammals that are circumpolar, in either the Northern or Southern Hemispheres (but not both) include the bowhead whale (*Balaena mysticetus*), Narwhal (*Monodon monoceros*), beluga whale (*Delphinapterus leucas*), Southern right whale dolphin (Lissodelphis peronii), hourglass dolphin (*Lagenorhynchus cruciger*), Arnoux's beaked whale (*Berardius arnuxii*), polar bear, crabeater seal (*Lobodon carcinophaga*), ringed seal, Weddell seal, Southern elephant seal (*Mirounga leonine*), and Ross seal (*Ommatophoca rossi*). Some cetaceans have circumpolar distribution during only part of the year; these include populations of humpback whales (*Megaptera novaeangliae)*, fin whales (*Balaenoptera physalus*), killer whales, and male sperm whales (*Physeter macrocephalus*).

A *coastal* distribution denotes an occurrence close to the coast and often includes adjacent waters over the continental shelf. Many marine mammals have a coastal distribution for part of all of their lives; these include many species of dolphins, porpoises, and some pinnipeds, as well as some baleen whales. The sea otter occurs almost exclusively in coastal waters.

Species that occur in the open sea, either year-round or for only a portion of the year, are *pelagic*. The sperm whale and many beaked whales are truly pelagic species, rarely coming near land except in places where the continental shelf is narrow and deep waters that abut the coastline. Any marine mammal whose distribution is partly to exclusively tied to ice is said to be *pagophilic*, or "ice-loving." Many of the pinnipeds breed and feed on or around ice. Bowhead whales spend much of its life in partly frozen waters and can travel considerable distances under ice. The beluga and Narwhal also spend much time in ice. It is also common to find aggregations of polar species in semipermanent areas of open water, known as polynyas. The polar bear spends much of its life on sea ice and swims considerable distances between ice floes.

Forty-five species of marine mammals (Table 3-9) may occur in the proposed action areas (Arctic, Antarctic, and Pacific Northwest). The entire list of marine mammal species, including a description of distribution and seasonality, is provided in Appendix A, Section A.3, and includes those species that would only be encountered during transit, identified as "Transit Only."[7] If a species is expected to be present in an action area (Arctic [during icebreaking], Pacific Northwest [during vessel functionality and maneuverability testing, post dry dock], or Antarctic [during icebreaking]) it is identified in Table 3-9 by the DPS or stock as expected in that geographic location. Although not specifically identified in Table 3-9, the assumption is that vessel movement, as it pertains to icebreaking or vessel performance post-dry dock, also applies to the proposed action areas identified in Table 3-9. The term "NA" means that the geographic location is "not applicable" for that species—the species is not expected to be found in that geographic location where the activity specified above is likely to occur (e.g., species is not expected to be present in the Arctic area where icebreaking is proposed), but is included for consistency.

[7] The term "Transit Only" indicates that the species would be encountered only during vessel noise and movement between Ports or icebreaking locations, but not found at any of the specified locations described above (e.g., expected between transit from Seattle and McMurdo Station) and more information on these "Transit Only" species can be found in Appendix A.

Table 3-9. Marine Mammal Species that May Be within the Proposed Action Areas whose Distribution Overlaps with Icebreaking (Arctic or Antarctic) or Vessel Performance Testing (Pacific Northwest)

Species	Arctic	Antarctic	Pacific Northwest (PNW)	Status[1]
Cetaceans: Mysticetes				
Blue whale *(Balaenoptera musculus)*	NA	Present	ENP stock	Global: Endangered CITES: App I IUCN: EN A1 adb[2]
Bowhead whale *(Balaena mysticetus)*	Western Arctic stock	NA	NA	Global: Endangered CITES: App I IUCN: EN
Fin whale (*Balaenoptera physalus)*	Northeast Pacific stock	Possible Presence	CA/OR/WA stock	Global: Endangered CITES: App I IUCN: EN A1d[2]
Gray whale (*Eschrichtius robustus*)	WNP Stock; ENP stock	NA	WNP Stock; ENP stock, PCFG	WNP DPS-Endangered CITES: App I IUCN: LC
Humpback whale (*Megaptera novaeangliae)*	WNP stock; CNP stock (stocks overlap on feeding grounds)	Present	CA/OR/WA stock (stocks overlap on feeding grounds)	WNP DPS and Central America DPS-Endangered Mexico DPS-Threatened CITES: App I IUCN: LC
Minke whale (Common) *(Balaenoptera acutorostrata)*	Common minke whale, Alaska stock	NA	Common minke whale; CA/OR/WA stock	CITES: App I and II (location dependent) IUCN: LC
Minke whale (Antarctic) *(Balaenoptera bonaerensis)*	NA	Present	NA	CITES: App I IUCN: DD
North Pacific right whale (*Eubalaena japonica)*	ENP stock	NA	ENP stock	Global: Endangered; Critical Habitat (71 FR 38277) CITES: App I IUCN: EN
Sei whale (*Balaenoptera borealis)*	NA	Possible Presence	ENP stock	Global: Endangered CITES: App I IUCN: EN

Species	Arctic	Antarctic	Pacific Northwest (PNW)	Status[1]
Cetaceans: Odontocetes				
Arnoux's beaked whale (*Berardius arnuxii*)	NA	Present	NA	CITES: App I IUCN: DD
Beluga whale (*Delphinapterus leucas*)	Beaufort Sea stock, Eastern Chukchi Sea stock	NA	NA	Cook Inlet DPS-Endangered Critical Habitat for CI Beluga (76 FR 20180) CITES: App II IUCN: NT
Baird's beaked whale (*Berardius bairdii*)	Alaska stock	NA	CA/OR/WA stock	CITES: App II IUCN: DD
Blainville's beaked whale (*Mesoplodon densirostris*)	NA	NA	Possible presence	CITES: App II IUCN: DD
Bottlenose dolphin (*Tursiops truncatus*)	NA	NA	CA/OR/WA stock	CITES: App II IUCN: LC
Cuvier's beaked whale (*Ziphius cavirostris*)	Alaska stock	NA	CA/OR/WA stock	CITES: App II IUCN: LC
Dall's porpoise (*Phocoenoides dalli*)	Alaska stock	NA	CA/OR/WA stock	CITES: App II IUCN: LC
Harbor porpoise (*Phocoena phocoena*)	Bering Sea stock	NA	Northern Oregon/Washington Coast stock; Washington Inland Waters stock	CITES: App II IUCN: LC
Hubb's beaked whale (*Mesoplodon carlhubbsi*)	NA	NA	Possible Presence	CITES: App II IUCN: DD
Killer whale (*Orcinus orca*)	AK (resident); At1 Transient; Gulf of AK, Aleutian Islands, Bering Sea Transient	Ecotype A, but mainly B and C	Northern (resident); Southern (resident); Offshore (resident); West Coast Transient	PNW: Southern Resident-Endangered Critical Habitat for Southern Resident (71 FR 69054) CITES: App II IUCN: DD
Narwhal (*Monodon Monoceros*)	Unidentified stock	NA	NA	CITES: App II IUCN: NT
Northern right whale dolphin (*Lissodelphis borealis*)	NA	NA	CA/OR/WA stock	CITES: App II IUCN: LC

Species	Arctic	Antarctic	Pacific Northwest (PNW)	Status[1]
Pacific white-sided dolphin (*Lagenorhynchus obliquidens)*	North Pacific stock	NA	CA/OR/WA, Northern and Southern stocks	CITES: App II IUCN: LC
Risso's dolphin (*Grampus griseus)*	NA	NA	CA/OR/WA stock	CITES: App II IUCN: LC
Short-beaked common dolphin (*Delphinus delphis)*	NA	NA	CA/OR/WA stock	CITES: App II IUCN: LC
Short-finned pilot whale (*Globicephalus macrorhynchus)*	NA	NA	Presence is oceanographic condition-dependent	CITES: App II IUCN: DD
Southern bottlenose whale (*Hyperoodon planifrons)*	NA	Present	NA	CITES: App II IUCN: LC
Sperm whale (*Physeter microcephalus)*	North Pacific stock	Possible Presence	CA/OR/WA stock	Endangered CITES: App I IUCN: VU A1d[2]
Stejneger's beaked whale (*Mesoplodon stejnegeri)*	Alaska stock	NA	Possible Presence	CITES: App II IUCN: DD
Striped dolphin (*Stenella coeruleoalba)*	NA	NA	CA/OR/WA stock	CITES: App II IUCN: LC
Pinnipeds:Otariids				
California sea lion (*Zalophus californianus)*	NA	NA	U.S. stock	IUCN: LC
Northern fur seal (*Callorhinus ursinus)*	Eastern Pacific stock	NA	Eastern Pacific stock	IUCN: VU A2b[4]
Steller sea lion (*Eumetopias jubatus)*	Western U.S. stock	NA	Eastern U.S. stock	Arctic: Western DPS-Endangered Critical Habitat (58 FR 4569) IUCN: NT
Pinnipeds: Phocids				
Bearded seal (*Erignathus barbatus)*	Alaska stock	NA	NA	Arctic: Threatened IUCN: LC
Crabeater seal (*Lobodon carcinophaga)*	NA	Present	NA	IUCN: LC

Species	Arctic	Antarctic	Pacific Northwest (PNW)	Status[1]
Harbor seal (*Phoca vitulina)*	Alaska stock	NA	Oregon/Washington stock; Washington Inland stock	IUCN: LC
Leopard seal (*Hydrurga leptonyx)*	NA	Present	NA	IUCN: LC
Northern elephant seal (*Mirounga angustirostris)*	NA	NA	California Breeding stock	IUCN: LC
Ribbon seal (*Histriophoca fasciata)*	Alaska stock	NA	NA	IUCN: LC
Ringed seal (*Phoca hispida)*	Alaska stock	NA	NA	Arctic: Proposed as Threatened, Critical Habitat proposed IUCN: LC
Ross Seal (*Ommatophoca rossi)*	NA	Present	NA	IUCN: LC
Southern Elephant Seal (*Mirounga leonine)*	NA	Present	NA	IUCN: LC
Spotted seal (*Phoca largha)*	Alaska stock	NA	NA	IUCN: LC
Weddell seal (*Leptonychotes weddellii*)	NA	Present	NA	IUCN: LC
Pinnipeds: Odobenids				
Pacific walrus (*Odobenus rosmarus)*	Alaska stock	NA	NA	Candidate species to list as Threatened CITES: App III IUCN: VU A3c[5]

Species	Arctic	Antarctic	Pacific Northwest (PNW)	Status[1]
Carnivores: Mustelids				
Sea otter (*Enhydra lutris)*	Northern sea otter (Southcentral Alaska, Southeast Alaska, and Southwest Alaska	NA	Northern sea otter (Washington stock) Southern sea otter (California stock)	Southwest Alaska DPS- Threatened Critical Habitat (Southwest Alaska DPS of the Northern sea otter 74 FR 51988) CITES: App I and II (dependent on location) IUCN: EN A2abe[6]
Carnivores: Ursids				
Polar bear (*Ursus maritimus)*	Southern Beaufort Sea stock, Alaska Chukchi/Bering Sea stock	NA	NA	Threatened, Critical Habitat (75 FR 76086) CITES: App II IUCN: VU A3c[7]

[1] Status: **IUCN Red List Categories (ver 3.1)**: **EX** - Extinct, **EW** - Extinct in the Wild, **CR** - Critically Endangered, **EN** - Endangered, **VU** - Vulnerable, **LR/cd** - Lower Risk/conservation dependent, **NT** - Near Threatened (includes LR/nt - Lower Risk/near threatened), **DD** - Data Deficient, **LC** - Least Concern (includes LR/lc - Lower Risk, least concern); **IUCN** = International Union for Conservation of Nature; **CITES** = Convention on International Trade in Endangered Species of Wild Fauna and Flora (www.cites.org); **APP** – Appendix I or II

[2] The blue whale is assessed under criterion A1 because the cause of this population's reduction (commercial whaling) is reversible, understood, and is currently not under operation. The fin whale was assessed under criterion A1, not under A2, A3 or A4. The analysis in this assessment estimates that the global population has declined by more than 70% over the last three generations (1929–2007), although in the absence of current substantial catches it is probably increasing. The sperm whale population is evaluated under IUCN criterion, A1, rather under A2-4 criteria because a peer-reviewed publication (Whitehead 2002) provided a model-based estimate of global trend that can be used to evaluate the population under the A1 criterion, thus the specific notation.

[3] Also known as the Layard's beaked whale

[4] Northern fur seal is evaluated under criterion A2b due to the fact that the causes of the reduction do not appear to have ceased, are not understood, and may not be reversible based on the unknown cause, and that an index of abundance appropriate to the taxon (direct counting and mark-recapture) was used to assess population size).

[5] The walrus was evaluated using criterion A3c because of the consideration of both the certainty of future decline in their habitat quality and the limitations of abundance and trend data.

[6] The sea otter was evaluated under criterion A2abe based on based on past large-scale population declines.

[7] The polar bear was evaluated under criterion A3c because of the significant probability, across scenarios, of a reduction in mean global population size greater than 30%, and the relatively low probability of a reduction greater than 50%.

3.2.7.1 Arctic Proposed Action Overview

Data collection in the Arctic is limited by accessibility (seasonal) and logistical constraints. The Arctic Region is being defined to include waters off the coast of northern Alaska, north of 60° N latitude (Figure 3-10). This boundary was used to separate those marine mammals expected in the Arctic proposed action area from those that could be observed in proximity to and through the Bering Strait and into the Chukchi Sea, but not likely (based on the best available science) to be within the proposed action area where icebreaking is expected. Marine mammal occurrence is separated into the following marine mammal groups: mysticetes, odontocetes, and pinnipeds and carnivores.

Mysticetes observed in the Arctic Region in proximity to the proposed action area include the bowhead whale and the gray whale (*Eschrichtius robustus)*. Odontocetes observed in the Arctic Region in proximity to the proposed action area include the beluga whale and the Narwhal. Killer whales are expanding their range in the Arctic and although they typically do not range beyond the Chukchi Sea into the Beaufort Sea, they may expand into the Beaufort Sea in the future as ice conditions change. Pinniped and carnivore species observed in the Arctic Region in proximity to the proposed action area include the bearded seal, spotted seal (*Phoca largha*; maybe more coastal than where icebreaking would take place), polar bear, and ringed seal.

The following marine mammals may be observed in the Arctic Region north of 60° N on either the Pacific or Atlantic, but are not expected in the proposed action area where icebreaking would take place, and are not discussed further, but maybe evaluated in Appendix A, if applicable to vessel noise and movement (in transit): mysticetes: blue whale (*Balaenoptera musculus;* Atlantic only), fin whale (Pacific -not above Bering Strait; Atlantic), humpback whale (Pacific -not above Bering Strait; Atlantic), minke whale (*Balaenoptera acutorostrata;* Pacific -through Bering Strait but not in Beaufort Sea; Atlantic), North Pacific right whale (*Eubalaena japonica;* Pacific -not above Bering Strait); odontocetes: Atlantic white-sided dolphin (*Lagenorhynchus acutus;* Atlantic), Dall's porpoise (*Phocoenoides dalli*; Pacific-not north of St. Lawrence Island), harbor porpoise (*Phocoena phocoena*; Pacific and Atlantic, but coastal), long-finned pilot whale (*Globicephala melas*; Atlantic), northern bottlenose whale (*Hyperoodon ampullatus*; Atlantic), Sowerby's beaked whale (*Mesoplodon bidens*; Atlantic), sperm whale (Atlantic), Stejneger's beaked whale (*Mesoplodon stejnegeri;* Pacific -not north of St. Lawrence Island), and white-beaked dolphin (*Lagenorhynchus albirostris*; Atlantic); pinnipeds: harp seal (*Pagophilus groenlandicus;* Atlantic), hooded seal (*Cystophora cristata*; Atlantic), Northern fur seal (*Callorhinus ursinus;* Pacific-not north of St. Lawrence Island), ribbon seal (*Histriophoca fasciata;* Pacific-extends into Chukchi Sea), Steller sea lion (*Eumetopias jubatus;* Pacific-just north of St Lawrence Island, but below the Bering Strait), walrus (Pacific-range does extend near proposed icebreaking area, but coastal distribution; Atlantic-coastal).

3.2.7.2 Antarctic Proposed Action Overview

Similar to the Arctic, data collection in the Antarctic is hampered by its limited (seasonal) accessibility and logistic constraints. The Antarctic Region is being defined to include waters south of 60° S latitude (Figure 3-10). The Southern Ocean often refers to waters surrounding Antarctica, but it should be noted that many cetaceans also occur into temperate waters in the Southern Hemisphere. For the purposes of this document, the two hemispheres (Northern and Southern) are divided into subheadings under each species account. Information on marine mammals in Antarctica and the Southern Ocean are under the subheading "Southern Hemisphere." Little is known about the range and distribution for most marine mammals in the Antarctic, specifically near McMurdo Station and Marble Point. However, when possible, any information specific to these locations in Antarctica is provided in detail under the species account. Cetaceans observed in the Antarctic Region (inhabiting waters south of 60° S) include Arnoux's beaked whale, blue whale, fin whale, hourglass dolphin, humpback whale, killer whale, long-finned pilot whale, minke whale (dwarf and Antarctic), sei whale (*Balaenoptera borealis*), Southern bottlenose whale (*Hyperoodon planifrons*), Southern right whale (*Eubalaena australis)*, Southern right whale dolphin, spectacled porpoise (*Phocoena dioptrica*), and sperm whale. Pinnipeds observed in the Antarctic Region (inhabiting waters/ice 60° S) include Antarctic fur seal *(Arctocephalus gazelle),* crabeater seal, elephant seal, leopard seal, Ross seal, and Weddell seal. Although, the hourglass dolphin, Southern right whale, spectacled porpoise, and Antarctic fur seal inhabit waters south of 60° S latitude, they are not expected to overlap with the Antarctic proposed action area and icebreaking and are therefore discussed, if applicable, to vessel noise and movement (in transit), in Appendix A.

3.2.7.3 Pacific Northwest Proposed Action Overview

The following cetaceans may be observed in or in the proximity to the Pacific Northwest proposed action area (Figure 2-4): beaked whales (Baird's [*Berardius bairdii*], Cuvier's [*Ziphius cavirostris*], Hubb's [*Mesoplodon carlhubbsi*], Stejneger's), killer whale, Northern right whale dolphin (*Lissodelphis borealis*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), pygmy and dwarf sperm whale (*Kogia breviceps* and *Kogia sima*, respectively), short-beaked common dolphin (*Delphinus delphis*), short-finned pilot whale (*Globicephala macrorhynchus*), striped dolphin (*Stenella coeruleoalba*), and Risso's dolphin (*Grampus griseus*). The following pinnipeds may be observed in or in the proximity to the Pacific Northwest proposed action area: California sea lion (*Zalophus californianus*), harbor seal (*Phoca vitulina*), Northern elephant seal (*Mirounga angustirostris)*, Northern fur seal, and Steller sea lion.

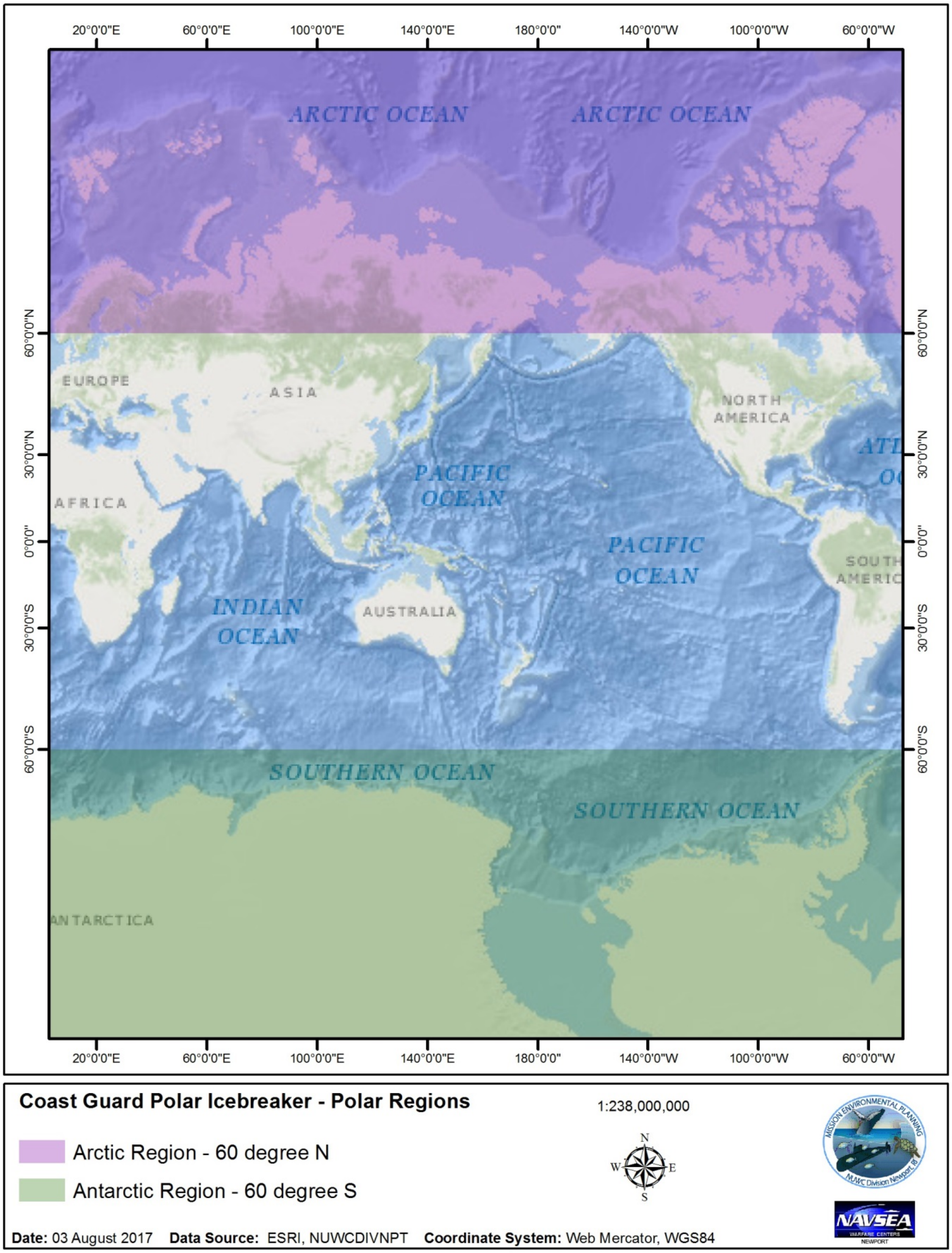


Figure 3-10. Arctic Region Defined as North of 60° N Latitude and Antarctic Region Defined as South of 60° S Latitude

3.2.7.4 ESA-Listed Marine Mammals

3.2.7.4.a Blue whale

The blue whale (*Balaenoptera musculus)* was listed as endangered under the Endangered Species Preservation Act of 1969 on December 2, 1970 (35 FR 18319), the predecessor to the ESA. When the ESA was passed in 1973, the blue whale was listed as endangered throughout its range. It is also listed as depleted and as a strategic stock under the MMPA. NMFS published a recovery plan for the blue whale in 1998 (NMFS 1998). No critical habitat is currently designated for this species. Blue whales may be found in the Pacific Northwest proposed action area, in proximity to the Antarctic proposed action area, or encountered in transit between all proposed action areas as described in Appendix A.

In general, blue whales are found in the open ocean, but they do come close to shore to feed and possibly to mate and breed. Blue whales feed primarily on various species of krill (euphausiids). They are observed from tropical waters to pack ice edges in both hemispheres, but are believed to avoid equatorial waters. Calves are born in winter, apparently in tropical/subtropical breeding areas (the specific locations of which are not known for most populations). The true blue whale (*B. m. musculus/indica/intermedia*) occurs in the Pacific, Atlantic, Southern, and portions of the Indian Ocean (see Section i). The pygmy blue whale (*B. m. brevicauda*) is smaller than the true blue whale and is found in the Southern Hemisphere (see Section ii), specifically in the Indian and southwestern South Atlantic oceans. Thus, in certain geographic areas, the true blue whale does overlap with the pygmy blue whale. The Western North Atlantic stock would overlap with the proposed transiting areas between the Northern and Southern Hemispheres and are discussed in Appendix A, as a species evaluated for "Transit Only."

<u>Subsistence or Whaling</u>

There are no reported takes of blue whales by Native subsistence hunters in the proposed action areas. Two sanctuaries are currently designated by the International Whaling Commission (IWC), both of which prohibit commercial whaling. The first of these, the Indian Ocean Sanctuary, was established in 1979 and covers the whole of the Indian Ocean south to 55° S. The second was adopted in 1994 and covers the waters of the Southern Ocean around Antarctica. Although the IWC banned commercial whaling, there are still some countries that do whale, particularly in the Southern Ocean. There are no known takes of blue whales from current whaling practices.

i. True blue whale

Northern Hemisphere

North Pacific blue whales were once thought to belong to as many as five separate populations (Reeves et al. 1998), but acoustic evidence suggests only two populations occur, in the eastern and western north Pacific (McDonald et al. 2006; Monnahan et al. 2014; Stafford 2003; Stafford et al. 2001). North Pacific blue whales produce two distinct acoustic calls, referred to as "northwestern" and "northeastern" types. It has been proposed that these represent distinct populations with some degree of geographic overlap (Monnahan et al. 2014; Stafford 2003; Stafford et al. 2001). The northeastern call predominates in the Gulf of Alaska, the U.S. West Coast, and the eastern tropical Pacific, while the northwestern call predominates from south of the Aleutian Islands to the Kamchatka Peninsula in Russia, though both call types have been recorded concurrently in the Gulf of Alaska (Stafford 2003; Stafford et al. 2001). Photographs of blue whales in California have also been matched to individuals photographed off the Queen Charlotte Islands in northern British Columbia and to one individual photographed in the northern Gulf of Alaska (Calambokidis et al. 2009b). Gilpatrick and Perryman (2008) showed that blue whales from California to Central America (the Eastern North Pacific [ENP] stock) are on average, two meters shorter than blue whales measured from historic whaling records in the central and western north Pacific. The ENP stock of blue whales includes animals found in the eastern North Pacific from the northern Gulf of Alaska to the eastern tropical Pacific and would overlap with the Pacific Northwest proposed action area. Blue whales are not expected in the proposed action area in the Arctic, but could be encountered in transit between the Pacific Northwest and Arctic proposed action areas (see Appendix A).

Widespread whaling over the last century is believed to have decreased the blue whale population to approximately 1 percent of its pre-whaling population size (Branch et al. 2007; Monnahan 2014; Monnahan et al. 2014; Rocha et al. 2014; Širović et al. 2004). The best estimate of blue whale abundance is taken from the period 2008 to 2011, or 1,647 (Coefficient of Variation [CV]=0.07) whales (Carretta et al. 2017). Based on mark-recapture estimates described in Carretta et al. (2017), there is no evidence of a population size increase in this blue whale population since the early 1990s. A study by Redfern et al. (2013), determined that the number of blue whales struck by ships in the California Current likely exceeds the potential biological removal (2.3 animals) for this stock. Monnahan et al. (2015) used a population dynamics model to estimate that the ENP blue whale population was at 97 percent of carrying capacity in 2013 and suggest that density dependence explains the observed lack of a population size increase since the early 1990s. The authors estimate that the eastern North Pacific population likely did not drop below 460 whales during the last century, despite being targeted by commercial whaling. Conclusions about the population’s current status relative to carrying capacity depend upon assumptions that the population was already at carrying capacity before commercial whaling impacted the population in the early 1900s, and that carrying capacity has remained relatively constant since that time (Monnahan et al. 2015). If carrying capacity has changed significantly in the last century, conclusions regarding the status of this population would necessarily change (Monnahan et al. 2015). However, despite current analysis suggesting that the ENP population is at 97 percent of carrying capacity (Monnahan et al. 2015), blue whales are globally listed as “endangered.”

The U.S. West Coast is certainly one of the most important feeding areas in summer and fall (Bailey et al. 2009; Calambokidis et al. 2015; Calambokidis et al. 2009b; Mate et al. 2015), but increasingly, blue whales from the ENP stock have been found feeding to the north and south of this area during summer and fall. Nine ‘biologically important areas’ (BIAs) for blue whale feeding are identified, but all are off the California coast (Calambokidis et al. 2015). Most of this stock is believed to migrate south to spend the winter and spring in high productivity areas off Baja California, in the Gulf of California, and on the Costa Rica Dome (Calambokidis et al. 2009b). Blue whales observed in the spring, summer, and fall off California, Washington, and British Columbia are known to be part of a group that returns to feeding areas off British Columbia and Alaska (Calambokidis and Barlow 2004; Calambokidis et al. 2009a; Gregr et al. 2000; Mate et al. 1999; Stafford et al. 1999). Given that these migratory destinations are areas of high productivity and given the observations of feeding in these areas, blue whales can be assumed to feed year-round. Some individuals from this stock may be present year-round on the Costa Rica Dome (Reilly and Thayer 1990). However, it is also possible that some Southern Hemisphere blue whales will occur north of the equator during the austral winter. Thus, blue whales may also be encountered during proposed transit between the Northern and Southern Hemispheres (see Appendix A).

Southern Hemisphere

The Antarctic blue whale (*B. m. intermedia*), likely belongs to three populations that feed alongside each other but breed in separate oceans (Attard et al. 2016). They are pelagic and have a highly mobile lifestyle. They typically feed at higher latitudes during summer and migrate to breed at lower latitudes during winter. The population structure possibilities span from each population having a separate non-breeding ground or grounds, to sharing of a non-breeding ground or grounds between different populations (Attard et al. 2016). Blue whales could be encountered in the proximity of the Antarctic proposed action area.

ii. Pygmy Blue whale spp.

Northern Hemisphere

See description under Southern Hemisphere for potential areas of overlap in the Northern Hemisphere.

Southern Hemisphere

The exact distribution of the pygmy blue whale is not known. However, it is believed that pygmy blue whales are centered in the subantarctic zone of the Indian Ocean between 0 degrees East (°E) longitude and 80° E, especially around Prince Edward Island and the islands of Crozet and Kerguelen. They may also range westward into the southeastern South Atlantic and eastwards into the Tasman Sea. A population along the coast of Chile may also consist of this species. The winter range is virtually unknown, with scattered records from South Africa and Australia (Rice 1998). The pygmy blue whale complex (*Balaenoptera musculus* subspp.), which includes the Northern Indian Ocean population (*B. m. indica*), occurs primarily outside the central gyre of the Indian Ocean including the African northeastern coast, various islands in the Arabian Sea, and the western Australian coast to the Banda Sea, along the Australian southeastern coast to New Zealand (Zemsky and Sazhinov 1994), around Diego Garcia (Samaran et al. 2013), the western coast of South America (Peru and Chile), south of Madagascar, and around most of the Sub-Antarctic Islands (Prince Edward, Kerguelen, Crozet, Heard, and Amsterdam) during the austral summer (Ichihara 1966). Based on the known distribution of the pygmy blue whale, it is not expected in the Antarctic proposed action area, but it may be encountered in transit (see Appendix A).

3.2.7.4.b Bowhead whale

Bowhead whales (*Balaena mysticetus)* were protected at different times under the 1931 League of Nations Convention, the Endangered Species Preservation Act of 1966, and the Endangered Species Conservation Act of 1969 on December 2, 1970 (35 FR 18319). The Endangered Species Conservation Act ended commercial whaling in the United States. Bowhead whales were also listed in Appendix 1 of The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) of 1973. When the ESA was passed in 1973, the bowhead was listed as endangered throughout its range. It is also listed as depleted and as a strategic stock under the MMPA. No critical habitat is currently designated for this species, and no recovery plan has been published for this species. The IWC recognizes four stocks of bowhead whales worldwide (IWC 2010). The only bowhead whale stock found in U.S. waters is the Western Arctic stock (also designated as the Western Arctic stock under the MMPA), also known as the Bering-Chukchi-Beaufort stock (Rugh et al. 2003) or Bering Sea stock (Burns et al. 1993), which does overlap with the proposed action area in the Arctic.

Subsistence and Whaling

Bowhead whales have been taken for subsistence purposes for at least 2,000 years (Marquette and Bockstoce 1980; Stoker and Krupnik 1993). Subsistence takes have been regulated by a quota system under the authority of the IWC since 1977. The average annual subsistence take (by Natives of Alaska, Russia, and Canada) during the 5-year period from 2009 to 2013 was 44 bowhead whales (Muto et al. 2017). Since the exact location of the bowhead hunting area is dependent on where bowheads are located which varies annually, the hunting grounds could overlap with the Arctic proposed action area. In 1986, the IWC banned commercial whaling; however, there are still some countries that do whale, particularly in the Southern Ocean, but bowhead whales are not found in the Southern Ocean. Therefore, there are no known takes of bowhead whales from current whaling practices.

Northern Hemisphere

Bowhead whales are found only in Arctic and subarctic regions near sea ice and generally between 55° N and 85° N (Braham et al. 1984; Moore and Reeves 1993) of the North Atlantic and North Pacific Oceans (Rice 1998). They migrate to the high arctic in the summer and retreat southward in fall with the advancing ice edge. Their range can expand and contract depending on ice cover and access to Arctic straits (Rugh et al. 2003). Bowhead whales are found in the Bering, Beaufort, and Chukchi Seas, Russia, the northern parts of Hudson Bay, Canada (Wiig et al. 2007), and in western Greenland (Hudson Bay and Foxe Basin) and eastern Canada (Baffin Bay and Davis Strait). Evidence suggests that bowhead whales should be considered one stock based on genetics (Bachmann et al. 2010; Heide-Jørgensen et al. 2010; Postma et al. 2006; Wiig et al. 2010), aerial surveys (Cosens et al. 2006), and tagging data (Commission 2010; Dueck et al. 2006; Heide-JØrgensen et al. 2006; IWC 2010). The bowhead whale population, previously thought to include only a few hundred animals, may number over a thousand (Heide-JØrgensen et al. 2006; Wiig et al. 2011), and perhaps over 6,000 (IWC 2008).

During winter and spring in Alaska, bowhead whales are closely associated with sea ice (Citta et al. 2015; Moore and Reeves 1993; Quakenbush et al. 2010). Western Arctic bowhead whales are distributed in seasonally ice-covered waters of the Arctic and near-Arctic, generally north of 60° N and south of 75° N in the western Arctic Basin (Braham et al. 1984; Moore and Reeves 1993). The majority of the Western Arctic stock migrates annually from wintering areas (December to March) in the northern Bering Sea, through the Chukchi Sea in the spring (April through May) to the eastern Beaufort Sea in relatively ice free waters (Citta et al. 2015), where they spend much of the summer (June through early to mid-October) before returning again to the Bering Sea in the fall (September through December) to overwinter in select shelf waters in all but heavy ice conditions (Braham et al. 1980; Citta et al. 2015; Moore and Reeves 1993; Moore et al. 2000; Quakenbush et al. 2010).

The bowhead spring migration follows fractures in the sea ice around the coast of Alaska, generally in the shear zone between the shorefast ice and the mobile pack ice. Bowheads are one of the most commonly sighted cetaceans in the Chukchi Sea when the ice has receded during warm seasons (Aerts et al. 2013). Some bowhead whales are found in the western Beaufort, Chukchi, and Bering Seas in summer, and these are thought to be a part of the expanding Western Arctic stock (Citta et al. 2015; Clarke et al. 2013a; Clarke et al. 2014; Clarke et al. 2015; Rugh et al. 2003). Summer aerial surveys conducted in the western Beaufort Sea during July and August of 2012–2014 have had relatively high sighting rates of bowhead whales, including cows with calves and feeding animals (Clarke et al. 2014;

Muto et al. 2017) (NMML data, available online[8]). During the autumn migration through the Beaufort Sea, bowhead whales select shelf waters in all but "heavy ice" conditions, when they select slope habitat (Moore et al. 2000). In winter in the Bering Sea, bowheads often use areas with approximately 90 to 100 percent sea ice cover (Citta et al. 2015; Quakenbush et al. 2010), even when polynyas (areas of open water surrounded by ice) are available (Quakenbush et al. 2010). Bowheads are known to break through ice as thick as 24 in (60 cm). Heavy ice years in the autumn in the Beaufort Sea are becoming less common because of climate change, the resulting trend of delayed seasonal sea ice formation, and the dramatic reduction in volume of multi-year ice.

Mating occurs from late winter to spring, and calving occurs from April to June, both in the Bering Sea (Quakenbush et al. 2008). Several areas within the Chukchi and Beaufort Seas along the northern coast of Alaska are important to bowhead whales. In the Alaskan Beaufort Sea and northeastern Chukchi Sea, a reproductive area is in use during the month of October. Near Barrow Canyon, there is another area used from April to June for reproduction. In the eastern Chukchi and Alaskan Beaufort Sea, there is a migration area used from April to May.

Woodby and Botkin (1993) summarized previous efforts to estimate bowhead population size prior to the onset of commercial whaling. They reported a minimum worldwide population estimate of 50,000, with 10,400–23,000 in the Western Arctic stock (dropping to less than 3,000 at the end of commercial whaling). Brandon and Wade (2006) used Bayesian model averaging to estimate that the Western Arctic stock consisted of 10,960 (9,190–13,950; 5th and 95th percentiles, respectively) bowheads in 1848 at the start of commercial whaling. The 2011 ice-based estimate calculated by Givens et al. (2013) is 16,892 bowhead whales, but this does not include animals at Point Barrow—which are currently being analyzed based on resight data (Mocklin et al. 2012).

Evidence suggests that bowhead whales feed on concentrations of zooplankton throughout their range. However, prey includes various species of copepods, zooplankton, euphausiids, mysids, invertebrates, and fish (Budge et al. 2008; Rugh and Shelden 2009; Wiig et al. 2007). Likely or confirmed feeding areas include Amundsen Gulf and the eastern Canadian Beaufort Sea; the central and western U.S. Beaufort Sea; Wrangel Island; and the coast of Chukotka, between Wrangel Island and the Bering Strait (Ashjian et al. 2010; Clarke et al. 2013a; Clarke et al. 2014; Clarke et al. 2015; Lowry et al. 2004; Muto et al. 2016; Okkonen et al. 2011; Quakenbush et al. 2010) (Clarke et al. 2012, NMML data, available online[8]). Clarke and Ferguson (2010) also observed bowhead whales feeding during the summer in the northeastern Chukchi Sea. Large groups of bowhead whales have been documented feeding in the western Alaskan Beaufort Sea as early as July and continuing into October (Clarke et al. 2014; Ferguson et al. 2015). Thus, bowhead whales are likely to be present in the Arctic proposed action area.

Southern Hemisphere

Bowhead whales are not found in the Southern Hemisphere.

3.2.7.4.c Fin whale

The fin whale (*Balaenoptera physalus*) was listed as endangered under the Endangered Species Preservation Act of 1969 on December 2, 1970 (35 FR 18319), the predecessor to the ESA. When the ESA was passed in 1973, the fin whale was listed as endangered throughout its range. It is also designated as

[8] http://www.afsc.noaa.gov/nmml/cetacean/bwasp/flights_2014.php, accessed May 2017

"depleted" and classified as a strategic stock under the MMPA. No critical habitat is currently designated for the fin whale. NMFS published a recovery plan for the fin whale in 2010 (NMFS 2010a). Fin whales may be found in the Pacific Northwest, in proximity of the Antarctic proposed action areas, or encountered in transit between proposed action areas as described in Appendix A.

Fin whale populations exhibit differing degrees of mobility, presumably depending on the stability of access to sufficient prey resources throughout the year. Most groups are thought to migrate seasonally, in some cases over distances of thousands of kilometers. They feed intensively at high latitudes in summer and fast, or at least greatly reduce their food intake, at lower latitudes in winter. Some groups apparently move over shorter distances and can be considered resident in areas with a year-round supply of adequate prey. The fin whale is a cosmopolitan species with a generally anti-tropical distribution centered in the temperate zones and inhabiting oceanic waters of both hemispheres. In the North Pacific, fin whales are found in the Bering and Chukchi Seas, and along the coast of Alaska. While in the North Atlantic, they can be seen around Canada, Greenland, Iceland, northern Norway, Spitsbergen and the Barents Sea. They are relatively rare in tropical waters or near pack ice in the polar seas. In areas of the Southern Hemisphere where the species was once hunted intensively, they are rarely encountered today. Fin whales, typically if observed nearshore, are in deeper water as they approach the coast. They exhibit a poleward shift to feeding areas in the summer and towards the tropics in the winter for breeding. Calving does not appear to take place in distinct nearshore areas and not much is known of the social or mating system of fin whales. However, there are some resident groups observed in specific geographic areas (Jefferson et al. 2014). Fin whales feed on small invertebrates (euphausiids and copepods), schooling fish (capelin [*Mallotus villosus*], herring, mackerel, sandlance, and blue whiting [*Micromesistius poutassou*]), and squid.

<u>Subsistence or Whaling</u>

There are no reported takes of fin whales by Native subsistence hunters in the proposed action area. Two sanctuaries are currently designated by the IWC, both of which prohibit commercial whaling. The first of these, the Indian Ocean Sanctuary, was established in 1979 and covers the whole of the Indian Ocean south to 55° S. The second was adopted in 1994 and covers the waters of the Southern Ocean around Antarctica. Although the IWC banned commercial whaling, there are still some countries that do whale, particularly in the Southern Ocean. A certain number of fin whales are killed each year from current whaling practices.

Northern Hemisphere

In the Northern Hemisphere, several fin whale stocks are observed: within U.S. Pacific waters, three stocks of fin whales are currently recognized under the MMPA: (1) Northeast Pacific; (2) California/Oregon/Washington; and, (3) Hawaii (Muto et al. 2017); within U.S. Atlantic waters there is one stock currently recognized under the MMPA: the Western North Atlantic stock. The California/Oregon/Washington stocks are likely to be present in the Pacific Northwest proposed action area. The range for the Northeast Pacific stock of fin whales is farther south than the Arctic proposed action area and is therefore included in the discussion, along with the Hawaii and Western North Atlantic fin whale stocks, in Appendix A, as species evaluated for "Transit Only."

Reliable estimates of current and historical abundance for the entire Northeast Pacific fin whale stock are currently not available. Although the full range of the Northeast Pacific stock of fin whales in Alaskan waters has not been surveyed, a rough estimate of the size of the population west of the Kenai

Peninsula has been calculated by totaling the estimates from (Moore et al. 2002; Zerbini et al. 2006) (n = 5,700). There are also indications that fin whale distribution in the Bering Sea is related to oceanographic conditions (Friday et al. 2013; Stabeno et al. 2012), making it possible that whales could be double counted when estimates from different years are summed (Moore et al. 2002). Therefore, the best provisional estimate of the fin whale population west of the Kenai Peninsula would be 1,368, the greater of the minimum estimates from the 2008 and 2010 surveys (Friday et al. 2013). This is a minimum estimate for the entire stock because it was estimated from surveys which covered only a small portion of the range of this stock. Zerbini et al. (2006) and Friday et al. (2013) estimated rates of increase of fin whales in coastal waters of the Alaska Peninsula. The apparent rate of change in abundance estimates between estimates of Zerbini et al. (2006) of 4.8 percent and Friday et al. (2013) of 14 percent, is due at least in part to changes in distribution and not just to changes in overall population size. Friday et al. (2013) found that the abundance of fin whales in the survey area increased in colder years, likely due to shifts in the distribution of prey.

The best estimate of fin whale abundance in California, Oregon, and Washington waters out to 300 nm is from a trend-model analysis of line-transect data from 1991 through 2008 (Moore and Barlow 2011), which generated an estimate for 2008 of 3,051 (CV=0.18). The trend-model analysis incorporates information from the entire 1991–2008 time series for each annual estimate of abundance and given the strong evidence of an increasing abundance trend over that time (Moore and Barlow 2011); the best estimate of abundance is represented by the model-averaged estimate for the most recent year, or 2008. This is probably an underestimate because it excludes some fin whales which could not be identified in the field and which were recorded as “unidentified rorqual” or “unidentified large whale.”

Southern Hemisphere

The geographic area for the fin whale subspecies, *Balaena physalus quoyi* (Fischer 1829), for the purposes of this document, is considered to be the Southern Hemisphere. However, Clarke (2004) presented evidence that fin whales from mid-latitudes in the Southern Hemisphere are smaller and darker in coloration, and he proposed they be recognized as a different subspecies, *B. p. patachonica* (Burmeister 1865). In effect, these pygmy fin whales are comparable to the pygmy blue whale subspecies, segregated during the austral summer from their sister subspecies further south (NMFS 2010a). Nearly 750,000 fin whales were killed in areas of the Southern Hemisphere alone between 1904 and 1979, and there are no reliable population abundance estimates for fin whales in the Southern Hemisphere (NMFS 2010a).

Fin whale aggregation areas in the Southern Hemisphere (excluding Australia) include the South Pacific Ocean, the Southern Ocean and the Indian Ocean including the coasts of New Zealand, Peru, Brazil, and South Africa (Gambell 1985). It is likely that fin whales migrate between Australian waters and the following external waters: Antarctic feeding areas (the Southern Ocean); subantarctic feeding areas (the Southern Subtropical Front); and tropical breeding areas (Indonesia, the northern Indian Ocean and south-west South Pacific Ocean waters) (IWC IDCR/SOWER database). Fin whales are rarely seen close to ice (Mackintosh 1966); although, recent sightings have occurred near the ice edge of Antarctica during Southern Ocean Whale and Ecosystem Research (SOWER) cruises (IWC IDCR/SOWER database). Thus, fin whales may be encountered during the Proposed Action in the Antarctic.

3.2.7.4.d Gray whale

Two genetically distinct populations of gray whales (*Eschrichtius robustus)* are currently recognized (Reilly et al. 2008b): (1) the ENP DPS and (2) the Western North Pacific (WNP) DPS (Bonner 1986; LeDuc et al. 2002; Weller et al. 2013). The ENP gray whale was delisted from the ESA in 1994 (59 FR 31094; June 16, 1994). The WNP DPS is listed as endangered under the ESA. The WNP DPS is the only ESA-listed gray whale population with the potential to occur in the Pacific Northwest proposed action area, in vicinity to the Arctic proposed action area, and in transit between these two proposed action areas as described in Appendix A. No critical habitat is currently designated for the gray whale and no recovery plan has been published for this species.

<u>Subsistence and Whaling</u>

Subsistence hunters in Russia and the United States have traditionally harvested whales from the ENP gray whale stock in the Bering Sea; however, only the Russian hunt has persisted in recent years (Huelsbeck 1988; Reeves 2002). In 2005, the Makah Indian Tribe requested authorization from National Oceanic and Atmospheric Administration (NOAA)/NMFS, under the MMPA and the Whaling Convention Act, to resume limited hunting of gray whales for ceremonial and subsistence purposes in the coastal portion of their usual and accustomed fishing grounds off Washington State (73 FR 26375–26376). The spatial overlap of the Makah usual and accustomed grounds and the summer distribution of gray whales, specifically Pacific Coast Feeding Group whales, has management implications. Given conservation concerns for the WNP population, the Scientific Committee of the IWC emphasized the need to estimate the probability of a WNP gray whale being struck during aboriginal gray whale hunts (IWC 2012a). Although, observations of gray whales moving between the WNP and ENP highlight the need to estimate the probability of a gray whale observed in the WNP being taken during a hunt, this is likely only to occur during hunts conducted by the Makah Tribe (Moore and Weller 2013). The Makah Tribe hunting area is outside of the proposed action area and therefore, no subsistence of WNP gray whales is expected in the Pacific Northwest proposed action area.

Northern Hemisphere

Gray whales are restricted to shallow continental shelf waters for feeding and live most of their lives within a few tens of kilometers of shore. The WNP stock ranges from the coast of southern China to the Sea of Okhotsk. The ENP stock (see Section 3.2.7.5 on non-ESA marine mammals for more information) can be found in the Arctic—mainly in summer—and migrate from the Arctic to the lagoons in Mexico and back from October to June. A proportion of the WNP also makes this migration and may be found in the Pacific Northwest proposed action area.

The WNP gray whale stock has increased over the last 10 years (2002–2012) at an estimated realized average annual rate of population increase during this period of 3.3 percent per annum (± 0.5%) (Cooke et al. 2013). Photo-identification data collected between 1994 and 2011 on the gray whale summer feeding ground off Sakhalin Island in the WNP were used to calculate an abundance estimate of 140 (Standard Error= ± 6, CV=0.043) whales for the age 1-plus (non-calf) population size in 2012 (Cooke et al. 2013). Some whales (approximately 70 individuals) sighted during the summer off southeastern Kamchatka have not been sighted off Sakhalin Island, but it is as yet unclear whether those whales are part of the WNP stock (IWC 2014).

Tagging, photo-identification, and genetic studies show that some whales identified in the WNP off Russia have been observed in the ENP DPS' range, including coastal waters of Canada, the United States, and Mexico (Lang 2010; Mate et al. 2011; Mate et al. 2015; Urbán et al. 2013; Weller et al. 2012). During summer and fall, most whales in the ENP population feed in the Chukchi, Beaufort, and northwestern Bering Seas. An exception to this is the relatively small number of whales (approximately 200) that summer and feed along the Pacific coast between Kodiak Island, Alaska and northern California, referred to as the "Pacific Coast Feeding Group" (Calambokidis et al. 2012; Darling 1984; Gosho et al. 2011). In combination, studies have recorded 27 gray whales observed in both the WNP and ENP. Despite this overlap, significant mitochondrial deoxyribonucleic acid (DNA) and nuclear DNA differences are found between whales in the WNP and those summering in the ENP range (Lang et al. 2011).

WNP gray whales typically feed during summer and fall in the Okhotsk Sea off northeast Sakhalin Island, Russia, and off southeastern Kamchatka in the Bering Sea (Burdin et al. 2013; Tyurneva et al. 2010; Vertyankin et al. 2004; Weller et al. 2002; Weller et al. 1999). The WNP DPS' summer and fall feeding grounds do not overlap with the proposed action area in the Arctic or off the Pacific Northwest. Although some proportion of WNP gray whales follow the ENP's migration route, the likelihood that a WNP gray whale would feed in the ENP's feeding grounds is low and therefore, the likelihood that a WNP gray whale would be in the proposed action area is also low. The migratory corridor for ENP gray whales is within 10 kilometers from shore and is not expected to overlap with the Pacific Northwest proposed action area. Therefore, even if a WNP gray whale followed this migration route, the likelihood that a WNP gray whale would be present in the proposed action area is extremely low.

Southern Hemisphere

Gray whales are not found in the Southern Hemisphere.

3.2.7.4.e Humpback whale

The humpback whale *(Megaptera novaeangliae)* was listed as endangered under the Endangered Species Preservation Act of 1969 on December 2, 1970 (35 FR 18319), the predecessor to the ESA. When the ESA was passed in 1973, the humpback whale was listed as endangered throughout its range. No critical habitat is currently designated for the humpback whale. NMFS published a recovery plan for the humpback whale in 1991 (NMFS 1991). NMFS has identified 14 DPSs, some with a different ESA-listing status (some are listed as endangered, some as threatened, and others are no longer listed as endangered or threatened). Of the 14 DPSs identified, three DPSs of humpback whales occur in the waters off the coast of Alaska: the WNP, which is an endangered species under the ESA; the Hawaii DPS (n=10,000 (Bettridge et al. 2015), which is not protected under the ESA; and the Mexico DPS (n=6,000–7,000 (Bettridge et al. 2015), which is a threatened species under the ESA. Whales from these three DPSs overlap to some extent on feeding grounds off Alaska. Other humpback whale DPSs and those designated as stocks under the MMPA that are not discussed in this section are found in Appendix A, as species evaluated for "Transit Only." Humpback whales may be found in all proposed action areas or encountered in transit between all proposed action areas as described in Appendix A.

Humpback whales are found in all oceans of the world with a broad geographical range from tropical to temperate waters in the Northern Hemisphere and from tropical to near-ice-edge waters in the Southern Hemisphere. The only places where they are clearly absent are in some equatorial regions, a few enclosed seas, and some parts of the high Arctic. Nearly all populations undertake seasonal migrations between their tropical and sub-tropical winter calving and breeding grounds and high-latitude summer feeding grounds. They typically migrate from wintering grounds in the tropics to temperate and polar summering grounds, reaching ice edge in both hemispheres. Humpback whales travel great distances during their seasonal migration, the farthest migration of any mammal. The longest recorded migration was 11,706 mi (18,840 km), with a trek from American Samoa to the Antarctic Peninsula. One of the more closely studied routes is between Alaska and Hawaii, where humpbacks have been observed making the 3,000 mi (4,830 km) trip in as few as 36 days. A total of 24 wintering areas were determined worldwide, all within 30° of the equator (Rasmussen et al. 2007). Humpback whales are currently considered to be a monotypic species, but whales from the Northern and Southern Hemispheres differ from each other substantially in a number of traits, including coloration, timing of reproduction and migratory behavior, diet, and molecular genetic characteristics (Bettridge et al. 2015). Humpback whales have a diverse diet, feeding largely on krill and a wide variety of small schooling fish (e.g., herring, sand lance, mackerel, sardines, anchovies, and capelin).

Subsistence and Whaling

There are no reported takes of humpback whales by Native subsistence hunters in the proposed action areas. Two sanctuaries are currently designated by the IWC, both of which prohibit commercial whaling. The first of these, the Indian Ocean Sanctuary, was established in 1979 and covers the whole of the Indian Ocean south to 55° S. The second was adopted in 1994 and covers the waters of the Southern Ocean around Antarctica. Although the IWC banned commercial whaling, there are still some countries that do whale, particularly in the Southern Ocean. There are no known takes of humpback whales from current whaling practices.

Northern Hemisphere

NMFS identified eight DPSs in the Northern Hemisphere: six DPSs in the North Pacific and two in the North Atlantic (Bettridge et al. 2015). At this time, NMFS has not updated the annual marine mammal stock assessment reports to reflect the ESA-listing status revision as it relates to the stocks designated under the MMPA. Since it is unknown, at this time, which humpback whale DPS may be present in the proposed action areas at any given time, the Coast Guard considers that humpback whales in the proposed action areas are designated as listed under the ESA, but acknowledge that some may be from the non-ESA listed DPSs.

In the North Pacific, there are at least three separate humpback whale stocks designated under the MMPA: the California/Oregon/Washington stock, the Central North Pacific (CNP) stock, and the WNP stock. WNP and CNP stocks mix to a limited extent on summer feeding grounds that range from British Columbia through the central Gulf of Alaska and up to the Bering Sea (Muto et al. 2017); this area of overlap is bounded to the north in the Bering Sea by Bethel, Alaska. In summer, the majority of whales from the CNP stock are found in the Aleutian Islands, Bering Sea, Gulf of Alaska, and Southeast Alaska/northern British Columbia. High densities of humpback whales are found in the eastern Aleutian Islands, particularly along the north side of Unalaska Island, and along the Bering Sea shelf edge and break to the north towards the Pribilof Islands. Because a portion of the CNP stock distribution overlaps with the endangered WNP DPS, NMFS considers the combination of the WNP and CNP humpback whale stocks to also be endangered and depleted for MMPA management purposes, at this time. Humpback whales are not expected to overlap with the proposed action area in the Arctic, but would be expected in the Pacific Northwest action area.

The WNP DPS includes two DPSs: one that winters primarily in the Ryukyu Islands (e.g., Okinawa) and the Philippines, and a second that primarily winters in an unknown location. Both DPSs are thought to overlap in the Ogasawara Islands of Japan. As mentioned previously, information from a variety of sources indicates that humpback whales from the WNP and CNP stocks mix to a limited extent on summer feeding grounds. Point estimates of abundance for Asia ranged from 938 to 1,107 (for 2004–2006), but no associated CV has yet been calculated (Carretta et al. 2017). The Hawaii DPS consists of humpback whales that breed within the main Hawaiian Islands. From this breeding ground, about half of the whales migrate to southeast Alaska and northern British Columbia. The best population abundance estimate for Hawaii, which is where the CNP winters (Baker et al. 1986) (as chosen by AICc), ranged from 7,469 to 10,103; no confidence limit or CV was calculated for that estimate (Calambokidis et al. 2008; Carretta et al. 2017).

The Mexico DPS feeds across a broad geographic range from California to the Aleutian Islands, with concentrations in California and Oregon, northern Washington and southern British Columbia, and northern and western Gulf of Alaska and Bering Sea feeding grounds. Combining abundance estimates from both the California/Oregon and Washington/southern British Columbia feeding groups (1,729 + 189) yields an estimate of 1,918 (CV≈0.03) animals for the CA/OR/WA stock, which also overlaps with the Mexico DPS.

Humpback whales in the high latitudes of the North Pacific are seasonal migrants that feed on euphausiids and small schooling fishes (Clapham and Mead 1999; Nemoto 1957, 1959). Most humpback whale sightings are in nearshore and continental shelf waters; however, humpback whales frequently travel through deep oceanic waters during migration (Calambokidis et al. 2001; Clapham and Mattila 1990). They are typically found on high-latitude feeding grounds during the summer and in the tropics and subtropics around islands over shallow banks, and along continental coasts where calving occurs during the winter. In the North Pacific, humpback whales summer in the eastern Bering Sea, with some individuals occasionally entering the Arctic Ocean via the Bering Strait and remaining in areas along the Siberian coast of the Chukchi Sea (Johnson and Wolman 1984; Sleptsov 1970; Tomilin 1937). Hashagan et al. (2009) documented the first confirmed sighting of humpback whales in the Beaufort Sea, a cow/calf pair, where it was previously thought whales would not access because of their avoidance of colder waters associated with the polar ice pack (Chittleborough 1965; Dawbin 1966). However, Hashagan et al. (2009) noted that the presence of humpback whales in 2007 coincided with record minimal sea ice coverage and warmer water temperatures. Calambokidis et al. (2015) identified several biologically important areas off the U.S. West Coast and similarly, Ferguson et al. (2015) identified several areas in the Gulf of Alaska. Although there is a BIA in Northern Washington (from May-November), this species is evaluated in Appendix A, as species considered for “Transit Only,” as the proposed activity does not overlap with the BIA.

Analysis of whaling data shows historical catches of humpback whales well into the Bering Sea and catches in the Bering Strait and Chukchi Sea in August–October in the 1930s (Mizroch and Rice 2006). Humpback whales are increasingly seen north of the Bering Strait into the northeastern Chukchi Sea (Clarke et al. 2014; Clarke et al. 2013b), with some indication that more humpback whales are seen on the Russian side north of the Bering Strait (Clarke et al. 2013b) and in the summer along the north coast of the Chukotka Peninsula in the Chukchi Sea (Melnikov et al. 2000).

Southern Hemisphere

NMFS identified seven DPSs of humpback whales in the Southern Hemisphere (Bettridge et al. 2015). The IWC has been involved in the comprehensive assessment of humpback whales in the Southern Hemisphere since 1991, bringing together available information on distribution, migration, abundance, past exploitation, and population (stock) structure. The Southeastern Pacific humpback whale DPS consists of whales that breed/winter along the Pacific coasts of Panama to northern Peru (9° N–6° S), with the main wintering areas concentrated in Colombia. Feeding grounds for this DPS are thought to be concentrated in the Chilean Magellan Straits and the western Antarctic Peninsula. These cross-equatorial breeders feed in the Southern Ocean during much of the austral summer. Humpback whales do have the potential to overlap with the proposed action area in the Antarctic.

Both Matthews (1938) and Mackintosh (1942) reported humpback whale catches near the equator during the austral winter (July–October) off the western coasts of South America and Africa, and they suggested that some Southern Hemisphere whales winter in areas north of the equator. Modern research has confirmed this off Ecuador and Colombia (approx. 0–7° N (Félix and Haase 2001; Flórez – González et al. 1998)). Rasmussen et al. (2007) reported on wintering areas off the Pacific coast of Central America for humpbacks migrating from feeding areas off Antarctica. Humpback whales are the most abundant baleen whale in the nearshore waters of the Antarctic Peninsula, feeding on Antarctic krill during the summer months. Rasmussen et al. (2007) observed whales as far north as 11° N off Costa Rica, in an area also used by a boreal population during the opposite winter season, resulting in unique spatial overlap between Northern and Southern Hemisphere populations. The occurrence of such a northerly wintering area is coincident with the development of an equatorial tongue of cold water in the eastern South Pacific, a pattern that is repeated in the eastern South Atlantic. A survey of location and water temperature at the wintering areas worldwide indicates that they are found in warm waters (21.1–28.3° C), irrespective of latitude. Rasmussen et al. (2007) noted that while availability of suitable reproductive habitat in the wintering areas is important at the fine scale, water temperature influences whale distribution at the basin scale.

3.2.7.4.f Right whales

Right whales are considered one of the most endangered of all large whale species. The northern right whale (*Eubalaena glacialis*) was listed as endangered under the precursor to the ESA of 1973, the Endangered Species Conservation Act of 1969 (35 FR 18319; December 2, 1970), and remained on the list of threatened and endangered species after the passage of the ESA in 1973. In 2008, NMFS reclassified the northern right whale as two separate endangered species, North Pacific right whale (*E. japonica*) and North Atlantic right whale (*E. glacialis*) (73 FR 12024; March 6, 2008). NMFS published a recovery plan for the North Pacific right whale in 2013 (National Marine Fisheries Service 2013). The North Atlantic right whale is discussed in Appendix A, as species evaluated for “Transit Only.” The Southern right whale (*E. australis*) is listed as endangered (35 FR 8491; June 2, 1970) throughout its range (see Southern Hemisphere below). Based on the information provided below on North Pacific right whales, it is unlikely that they would be in the Pacific Northwest or Arctic proposed action areas and it is unlikely that the Southern right whale would be in the Antarctic proposed action area.

<u>Subsistence and Whaling</u>

There are no reported takes of North Pacific right whales by Native subsistence hunters in the proposed action areas. In 1986, the IWC banned commercial whaling; however, there are still some countries that do whale, particularly in the Southern Ocean. Therefore, there are no known takes of North Pacific right whales from current whaling practices. Even though commercial whaling during the 18th, 19th, and early 20th century depleted the populations of right whales throughout the Southern Hemisphere and in some areas nearly extirpated the population, whaling is not currently considered a threat to the species.

Northern Hemisphere

Although extremely rare in North Pacific, right whales have been reliably observed in southeastern Bering Sea shelf in April to September. Few sightings have been observed off the U.S. West Coast. There are two stocks of North Pacific right whales: the ENP and the WNP. The ENP is located primarily in the U.S. EEZ, with an estimated historical seasonal migration range extending from the Bering Sea and Gulf of Alaska in the north, down the West Coast of the United States to Baja California in the south. The eastern population is estimated to consist of approximately 30 individuals. The WNP is located primarily in the EEZs of the Russian Federation, Japan, and China. Its estimated historical seasonal migration range extends from north of the Okhotsk Sea to the coasts of China and Vietnam to the south. Scientists do not agree on the reliability of the only existing abundance estimate for the western population; the lower bound on this estimate is approximately 400 individuals, and there is disagreement about the validity of the underlying data (Reilly et al. 2008a). NMFS has also designated two areas as North Pacific right whale critical habitat: one in the Gulf of Alaska and one in the Bering Sea (73 FR 19000; April 8, 2008). Critical habitat in the Bering Sea is located approximately 35 nm north of King Cove in the Aleutian Islands. Icebreaking would not overlap with either critical habitat area (Figure 3-11), and as long as navigational safety is not compromised, the icebreaker would avoid any designated critical habitat areas during transit.

Right whale sightings have been very rare (notably for the ENP stock) and geographically scattered (some as far south as California), leading to persistent uncertainty regarding population size and distribution. Small populations and rarity of sightings make it very difficult to estimate current range, habitat use, and population parameters (National Marine Fisheries Service 2013). However, most right whale sightings in the past 20 years have occurred in the southeastern Bering Sea, with a few in the Gulf of Alaska, near Kodiak, Alaska (Shelden et al. 2005; Wade et al. 2011a; Wade et al. 2011b; Waite et al. 2003). Studies have shown the presence of right whales in the southeastern Bering Sea in July–January, with a peak in September and a sharp decline in detections in mid-November (Wright 2015). North Pacific right whales are observed consistently in this area, although it is clear from historical and Japanese sighting survey data that right whales often range outside this area and occur elsewhere in the Bering Sea (Clapham et al. 2004; LeDuc et al. 2001; Moore et al. 2002; Moore et al. 2000). The most recent population abundance estimate for the North Pacific right whale is between 28 and 31 individuals, and although this estimate may be reflective of a Bering Sea subpopulation, the total eastern North Pacific population is unlikely to be much larger (Wade et al. 2011a; Wade et al. 2006; Wade et al. 2011b).

North Atlantic and Southern Hemisphere right whales calve in coastal waters during the winter months. In the eastern North Pacific no such calving grounds have been identified (Scarff 1986), but it is assumed they would exhibit similar behavior and migrate to calving grounds. Unlike calving areas, more is known about right whale feeding areas. Based on recorded historical concentrations of whales in the Bering Sea and recent survey sightings, it is likely that feeding areas in the Okhotsk Sea and adjacent waters along the coasts of Kamchatka and the Kuril Islands, together with the Gulf of Alaska, have been important summer habitats for eastern North Pacific right whales (Brownell Jr. et al. 2001; Clapham et al. 2006; Clapham et al. 2004; Goddard and Rugh 1998; IWC 2001; Scarff 1986; Shelden et al. 2005).

Right whales preferentially inhabit areas with high zooplankton abundance and must therefore adapt their behavior based on prevailing basin-scale oscillations and multi-year processes that govern currents, productivity, and food web structure (Angell 2006; Greene et al. 2003; Gregr and Coyle 2009; Kenney 1998; Klanjscek et al. 2007; Miller et al. 2011). Zooplankton abundance and density in the Bering Sea has been shown to be highly variable and affected by climate, weather, ice extent, and oceanographic processes (Baier and Napp 2003; Napp and Hunt 2001). Right whales feed primarily on copepods, but stomach contents analysis revealed that right whales feeding in the Gulf of Alaska, Sea of Okhotsk, and the eastern Aleutian Islands consume primarily *Neocalanus plumchrus*, *Metridia* sp., and *N. Cristatus*, respectively (Omura 1958, 1986; Omura et al. 1970). The predominant prey species in the southeastern Bering Sea is *Calanus marshallae*, followed by *P. Newmani* and *A. Longiremis* (Coyle 2000; Tynan 1999; Tynan et al. 2001).

Migratory patterns of North Pacific right whales are unknown, although it is thought they migrate from high-latitude feeding grounds in summer to more temperate waters during the winter, possibly well offshore (Braham and Rice 1984; Clapham et al. 2004; Scarff 1986). A right whale sighted off Maui in April 1996 (Salden and Michelsen 1999) was identified 119 days later and 2,220 nm north in the Bering Sea (Kennedy et al. 2012). While the photographic match confirms that Bering Sea animals occasionally travel south, there is currently no reason to believe that either Hawaii or tropical Mexico have ever been anything except extralimital habitats for this species (Brownell Jr. et al. 2001).

The Coast Guard would follow SOPs and Best Management Practices (BMPs) described in Chapter 6 to minimize training impact or harm to biological resources, and there are specific measures to reduce impacts to North Pacific right whales.

Southern Hemisphere

The Southern right whale is the only right whale that occurs throughout the southern hemisphere from temperate to polar latitudes (20° and 60° S). Within this range, southern right whales migrate between low-latitude winter breeding grounds and higher latitude feeding grounds. The protection, conservation, and management of the southern right whale is addressed by the Antarctic Living Marine Resources Act (Australia), Marine Mammal Protection Act (New Zealand), New Zealand Biodiversity Strategy, Marine Living Resources Act (South Africa), and the Biodiversity Act (South Africa). For details on these efforts, see the 2007 Southern Right Whale Five-Year Review (NMFS 2007a). Lastly, southern right whales are protected by CITES and are listed as an Appendix I species, meaning the species is threatened with extinction and trade is allowed only in exceptional circumstances.

Southern right whales feed from spring to fall, and also in winter in certain areas. The primary food source for southern right whales is zooplankton (e.g., copepods and krill). For much of the year, their distribution is strongly correlated to the distribution of their prey. The IWC has identified the following locations as known feeding grounds for the southern right whale: Brazil, False Banks, and Falkland Islands (30°–50° S); South Georgia and Shag Rocks (53° S); Tristan da Cunha (40° S); South of 50° S; and Antarctic Peninsula (60°–70° S). These feeding areas do not overlap with the Antarctic proposed action area, but could overlap with transiting routes.

The distribution of winter breeding, calving, and nursing grounds is known with greater certainty than the feeding areas. They have been identified as South Africa, Argentina, Australia, and sub-Antarctic New Zealand. In South Africa, right whales are predominantly found along the Cape coast between Muizenberg and Woody Cape. In Argentina, the major nursery and calving grounds are located along

Península Valdés. In Australia, the main aggregations are found along the southern coasts of Western Australia, South Australia, and Tasmania. Within subantarctic New Zealand, the two primary winter concentrations occur off the Auckland and Campbell Islands. Southern right whales also occur off mainland New Zealand, Uruguay, Peru, Chile, Namibia, Madagascar, and Mozambique. However, less is known about right whales in these regions as their populations are smaller, sightings are less frequent, and little research has been done. These winter breeding, calving, and nursing grounds do not overlap with the Antarctic proposed action area, but could overlap with transiting routes.

Worldwide, the historical abundance of southern right whales is estimated at 60,000 (Best et al. 2005; Suisted and Neale 2004). Worldwide abundance of southern right whales in 1997 was estimated at about 7,000 (IWC 2001). Since 1997, a number of breeding stocks have been recovering at annual rates of approximately 7 percent.

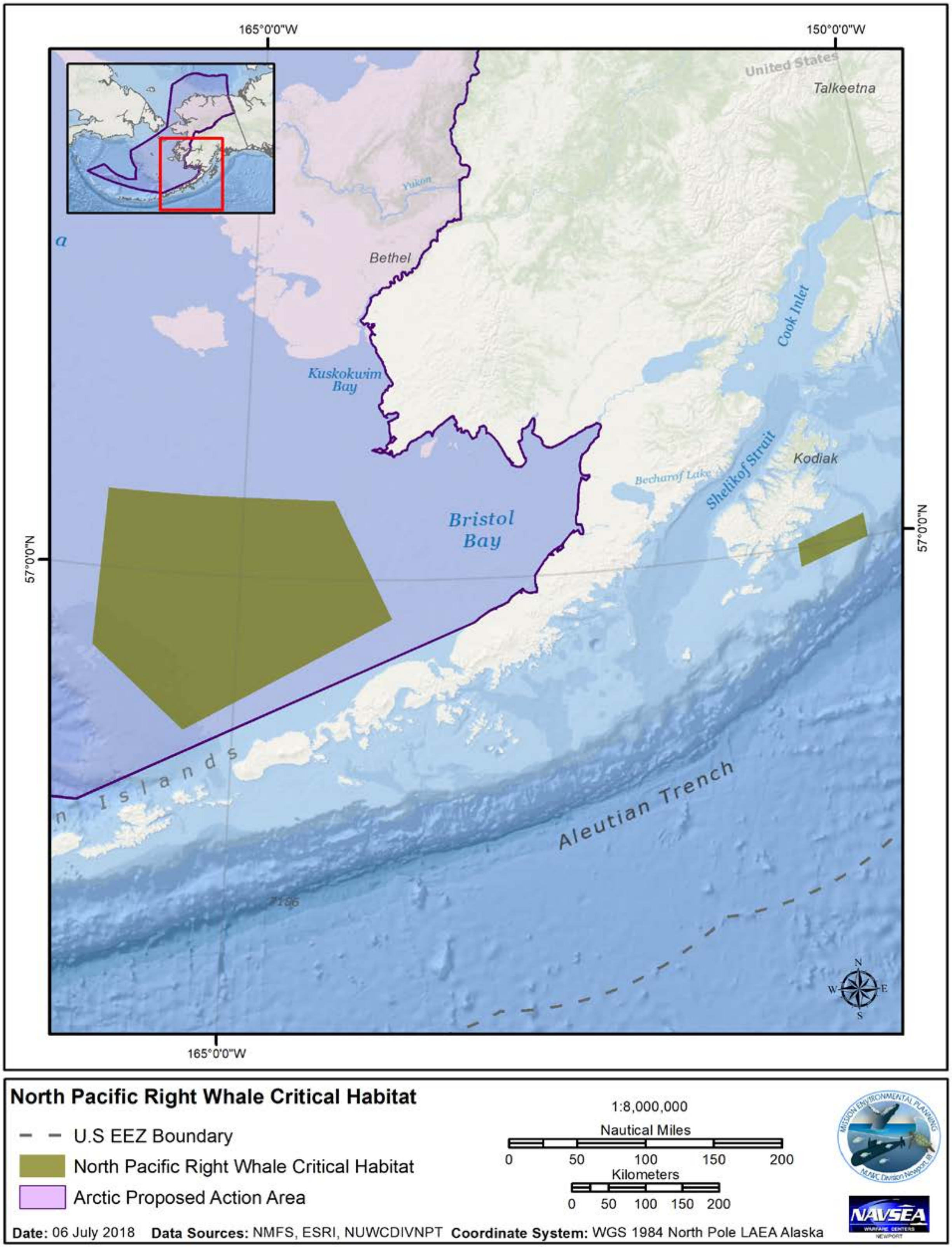


Figure 3-11. North Pacific Right Whale Critical Habitat in the Arctic Proposed Action Area

3.2.7.4.g Sei whale

The sei whale (*Balaenoptera borealis*) was listed as endangered under the Endangered Species Preservation Act of 1969 on December 2, 1970 (35 FR 18319), the predecessor to the ESA. When the ESA was passed in 1973, the sei whale was listed as endangered throughout its range. It is also designated as "depleted" and classified as a strategic stock under the MMPA. No critical habitat is currently designated for the sei whale. NMFS published a recovery plan for the sei whale in 2011 (NMFS 2011a). Sei whales have a global distribution and occur in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere, but are not often seen near the coast and occur from the tropics to polar zones in both hemispheres. Sei whales are more restricted to the mid-latitude temperate zone and undergo seasonal migrations. They have largely unpredictable patterns, but when they are present, they tend to be present in numbers (i.e., not singletons). Currently, the population structure of sei whales has not been adequately defined; therefore, populations are often divided on an ocean basin level (NMFS 2011a). Two subspecies have been identified (although not yet confirmed with empirical evidence): the northern sei whale (*Balaenoptera borealis borealis*) and southern sei whale (*Balaenoptera borealis schleglii*) (Rice 1998) although definitive conclusions regarding this classification cannot be made. Perrin et al. (2009), for example, noted that evidence for sei whale subspecies is weak. In any case, the ranges of these populations are not known to overlap (Rice 1998). Calving occurs in the midwinter, in low latitude portions of the species' range. Based on the information provided below on sei whales, they may be found in the Pacific Northwest and Antarctic proposed action areas or encountered in transit between proposed action areas as described in Appendix A.

<u>Subsistence and Whaling</u>

There are no reported takes of sei whales by Native subsistence hunters in the proposed action areas. In 1986, the IWC banned commercial whaling; however, there are still some countries that do whale, particularly in the Southern Ocean. There are no known takes of sei whales from current whaling practices.

Northern Hemisphere

In the North Pacific Ocean, the sei whale has been reported to occur mainly south of the Aleutian Islands (Leatherwood 1988; Nasu 1974), and although Japanese sighting records presented by Masaki (1977) reported concentrations in the northern and western Bering Sea from July through September, these data have never been confirmed (NMFS 2011a). Horwood's (1987) synoptic evaluation of the Japanese sighting data led him to conclude that sei whales "rarely penetrate deep into the Bering Sea." They occur, however, all across the temperate North Pacific north of 40° N latitude. In the south, they range from Baja California, Mexico to Japan and Korea in the west (Andrews 1916; Horwood 1987), and they have been documented in the Hawaiian Islands (Smultea et al. 2010). Ohsumi and Wada (1974) estimate the pre-whaling abundance of sei whales to be 58,000–62,000 in the North Pacific and (Tillman 1977) later revised this estimate to 42,000. The best abundance estimate for California, Oregon, and Washington waters out to 300 nm is 126 whales (Barlow 2010; Barlow and Forney 2007; Forney 2007).

Although rare, sei whales could be encountered in the Pacific Northwest proposed action area, but their presence would be strongly associated with oceanographic conditions. As few (n=9) have been observed off Washington during extensive surveys conducted between 1991 and 2008 (Barlow 2003, 2010; Carretta and Forney 1993; Forney 2007; Hill and Barlow 1992; Mangels and Gerrodette 1994; Von Saunder and Barlow 1999). Sei whales are not expected in the proposed action area in the Arctic, but could be encountered in transit between the Pacific Northwest and Arctic proposed action areas (see Appendix A). Although rare, sei whales could be encountered in the Pacific Northwest proposed action area, but their presence would be strongly associated with oceanographic conditions.

Studies in both the North Pacific and North Atlantic Oceans show that sei whales are strongly associated with ocean fronts and eddies (Nasu 1966; Nemoto and Kawamura 1977; Skov et al. 2008). A similar affinity for oceanic fronts was observed among sei whales in Antarctic waters (Bost et al. 2009). These are oceanographic features that likely concentrate prey—and may be exploited by feeding sei whales—that, in turn, are dependent on prevailing currents. These whales may also use currents in large scale movements or migrations (Olsen et al. 2009). Sei whales are considered to feed at somewhat higher trophic levels in the North Pacific than in the Southern Ocean (Nemoto and Kawamura 1977). In addition to calanoid copepods and euphausiids, sei whales in the North Pacific reportedly prey on pelagic squid and fish the size of adult mackerel (Kawamura 1982; Nemoto and Kawamura 1977). Off central California, mainly during the 1960s, sei whales fed mainly on anchovies from June through August and on krill (North Pacific krill) during September and October (Clapham et al. 1997; Rice 1977). In addition to the above mentioned prey, sei whales also feed on a variety of other fish species (including saury, whiting, lamprey, and herring) (Flinn et al. 2002).

Sei whales in the North Atlantic are not found in the Arctic proposed action area. However, sei whales may be encountered during transit and are therefore considered in Appendix A as species evaluated for "Transit Only."

Southern Hemisphere

In the Southern Hemisphere, the IWC has divided the Southern Ocean into six baleen whale feeding areas—designated at 60° S latitude and longitude as: 60°–120° W (Area I), 0°–60° W (Area II), 0°–70° E (Area III), 70°–130° E (Area IV), 130°–170° W (Area V), and 170°–120° W (Area VI). There is little information on the population structure of sei whales in Antarctic waters, although some degree of separation among IWC Areas I–VI has been noted, although sei whale movements appear to be dynamic and individuals have been observed to have moved between stock designation areas (Donovan 1991).

Sei whales occur throughout the Southern Ocean during the austral summer, generally between 40°–50° S (Gambell et al. 1985), feeding in these locations from December to April. During the austral winter, sei whales occur off Brazil and the western and eastern coasts of southern Africa and Australia; however, sei whales generally do not occur north of 30° S in the Southern Hemisphere (Reeves 1999). Confirmed sighting records exist for Papua New Guinea and New Caledonia, with unconfirmed sightings in the Cook Islands (Secretariat of the Pacific Regional Environmental Programme (SPREP) 2007). Sightings have been reported in the Golfo San Jorge, Argentina and near the Falkland Islands (Iñíguez et al. 2010) and a sei whale stranded in New Caledonia (ca. 21° S) in May 1962 (Borsa 2006). The species occurs between the subtropical convergence and the Antarctic convergence during the austral summer (Rice 1977). Therefore, sei whale distribution may overlap with the Antarctic proposed action area.

Southern Hemisphere sei whales exhibit feeding patterns and prey type selection that are similar to their Northern Hemisphere counterparts. In particular, sei whales feed primarily on copepods, but they may also take small shoaling fish and swarms of planktonic crustaceans (Bonner 1986; Iñíguez et al. 2010). In certain Southern Hemisphere locations, relatively large feeding aggregations have been observed (Reeves et al. 2002).

Braham (1992) provided an estimate of 65,000 (no CV) individuals in the Southern Hemisphere pre-exploitation sei whale population; and Mizroch et al. (1984) estimated 63,100 sei whales (no CV) occurred in these waters prior to exploitation. In the Southern Hemisphere, more recent population estimates range between 9,800 and 12,000 (no CV) sei whales (Mizroch et al. 1984; Perry et al. 1999). The IWC reported an estimate of 9,718 sei whales (no CV) based on results of surveys between 1978 and 1988 (IWC 1996).

3.2.7.4.h Southern Resident Killer whale

Killer whales (*Orcinus orca*) are the largest cetacean in the dolphin family, Delphinidae. They are the most cosmopolitan of all cetaceans—they can be seen in any marine region, from equator to ice edges and occur in many enclosed seas. They are generally more common in nearshore areas and at higher latitudes, with a few sightings from tropical regions (Dahlheim and Heyning 1999; Forney and Wade 2006). There are three identified ecotypes: Type A are found in all oceans and seas, from ice edges to more common nearshore, cool temperate to subpolar waters; Type B are found mainly in Antarctic and surrounding waters, often in pack ice (mainly near Antarctic Peninsula); Type C are also an Antarctic form, but prefer East Antarctica, mainly in pack ice. In the northeastern Pacific Ocean residents (“fish-eating”), transients (“mammal-eating”), and offshore killer whales (fish and shark eaters), are found. While there is considerable overlap in their geographic range, these ecotypes are genetically distinct and do not appear to interbreed. Killer whales may be found in all proposed action areas or encountered in transit between all proposed action areas as described in Appendix A.

The differences between ecotypes also extend to their morphology, foraging ecology, behavior, and acoustic repertoire. Southern Resident killer whales (SRKW) are the only known resident population to occur in the United States. Southern residents are comprised of three pods: J, K, and L pods, but SRKWs are considered one "stock" under the MMPA and one DPS. The SRKW was listed as endangered under the ESA in 2005 (70 FR 69903; November 18, 2005) and critical habitat is also designated (71 FR 69054; November 29, 2006) (Figure 3-12). No other killer whale is listed under the ESA. NMFS published a recovery plan for the SRKW in 2008 (NMFS 2008a). Non-ESA listed killer whales that have the potential to overlap with the proposed action areas in the Northern and Southern hemispheres are discussed in Section 3.2.7.5, and all other killer whales in the Northern and Southern hemispheres are discussed in Appendix A, as species evaluated for “Transit Only.” There are no SRKWs in the Atlantic.

<u>Subsistence and Whaling</u>

There are no reported takes of killer whales by Native subsistence hunters in the proposed action areas. In 1986, the International Whaling Commission banned commercial whaling; however, there are still some countries that do whale, particularly in the Southern Ocean. There are no known takes of Southern Resident killer whales from current whaling practices.

Northern Hemisphere

Killer whales are found throughout the North Pacific. In the North Pacific, killer whales occur in waters off Alaska, including the Aleutian Islands and Bering Sea (Braham and Dahlheim 1981; Dahlheim 1994, 1997; Matkin and Saulitis 1994; Miyashita et al. 1996; Murie 1959; Waite et al. 2002), and range southward along the North American coast and continental slope (Black 1997; Dahlheim et al. 1982; Fiscus and Niggol 1965; Gilmore 1976; Guerrero-Ruiz et al. 1998; Norris and Prescott 1961). They are also found in British Columbia and in inland waterways in Washington (Bigg et al. 1990). Populations are also present along the northeastern coast of Asia from eastern Russia to southern China (Kasuya 1971; Miyashita et al. 1995; Nishiwaki and Handa 1958; Tomilin 1967; Wang 1985; Zenkovich 1938). Northward occurrence in this region extends into the Chukchi and Beaufort Seas (Ivashin and Votrogov 1981; Lowry et al. 1987; Matkin and Saulitis 1994; Melnikov and Zagrebin 2005).

Resident killer whales in the Northeast Pacific are distributed from Alaska to California, with four distinct communities recognized: southern, northern, southern Alaska, and western Alaska (Krahn et al. 2004; Krahn et al. 2002). As mentioned above, SRKWs consist of three pods, designated J, K, and L pods, that reside part of the year in the inland waterways of Washington State and British Columbia (Strait of Georgia, Strait of Juan de Fuca, and Puget Sound), principally during the late spring, summer, and fall (Bigg 1982; Ford et al. 2000; Krahn et al. 2002), visiting coastal areas as far south as Monterey, California. Winter and early spring movements and distribution are largely unknown for the population.

The SRKW population is currently estimated at about 80 whales, a decline from its estimated historical level of about 200 during the late 1800s. Their range during the spring, summer, and fall includes the inland waterways of Washington State and the transboundary waters between the United States and Canada. Relatively little is known about the winter movements and range of the SRKW; however, in recent years they have been regularly spotted as far south as central California (off Monterey, California) during the winter months and as far north as Southeast Alaska. Critical habitat was designated in 2006 (71 FR 69054; November 29, 2006), but in 2015 NMFS received a petition to modify existing critical habitat to include Pacific Ocean marine waters along the West Coast of the United States that constitute essential foraging and wintering areas for the SRKW (80 FR 9682; February 24, 2015). Although it has yet to be published, NMFS intends to publish a proposed rule on the revised critical habitat. Transit from drydock to the Pacific Northwest proposed action area would overlap with SRKW critical habitat; however, the critical habitat does not overlap with the Pacific Northwest proposed action area. Recent tagging research conducted by NMFS' Northwest Fisheries Science Center[9] show SRKW staying at or east of the 656 ft (200 m) isobath off of Puget Sound and San Juan De Fuca. The proposed action area does not overlap with this bathymetric feature; therefore, the proposed action area off the Pacific Northwest would not overlap with the SRKW critical habitat (Figure 3-12). Vessel transit from the current homeport in Seattle, Washington, would overlap with SRKW critical habitat; however, the exact homeport location is not known at this time, therefore no further analysis was conducted in this PEIS.

[9] Accessed Northwest Fisheries Science Center website: https//www.nwfsc.noaa.gov/research/divisions/cb/ecosystem/marinemammal/satellite_tagging

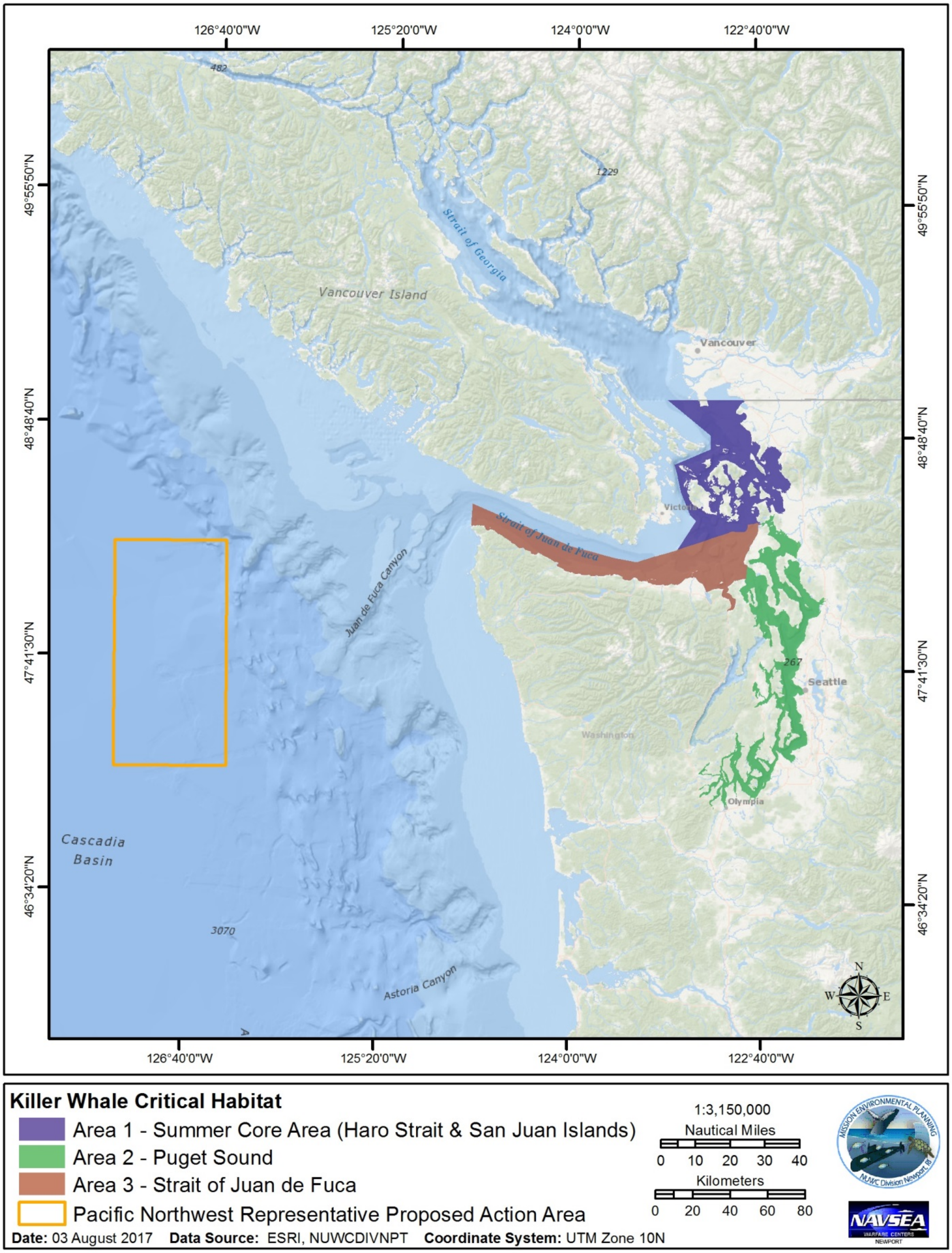


Figure 3-12. Southern Resident Killer Whale Critical Habitat and the Pacific Northwest Proposed Action Area

Southern Hemisphere

There are no Southern Resident killer whales in the Southern Hemisphere. Non-ESA listed killer whales that occur in the Southern Hemisphere are discussed in Section 3.2.7.5.

3.2.7.4.i Sperm whale

The sperm whale (*Physeter macrocephalus*) was listed under the precursor to the ESA, the Endangered Species Conservation Act of 1969, and remained on the list of threatened and endangered species after the passage of the ESA in 1973 (35 FR 18319; December 2, 1970). No critical habitat has been designated for this species. A final recovery plan for the species was published in December 2010 (NMFS 2010b). Sperm whales have a global distribution that is thought to be more extensive than any other marine mammal; the whale can be found in the Atlantic, Pacific, and Indian Oceans. Currently, the population structure of sperm whales has not been adequately defined. The distribution of sperm whales extends to all deep ice-free marine waters from the equator to the edges of polar pack ice (Rice 1989). Sperm whales are present in many warm-water areas throughout the year, and such areas may have discrete "resident" populations (Drout 2003; Engelhaupt 2004; Gordon et al. 1998; Jaquet et al. 2003; Watkins 1985). Sperm whales are a cosmopolitan species and are observed from the tropics to pack ice edges in both hemispheres, inhabiting deep waters and semi-enclosed seas with deep entrances. Large males tend to venture to the extreme northern and southern portions of the range (poleward of 40–50°). Sperm whales feed on a variety of cephalopods (squid [*Architeuthis*, *Moroteuthis*, *Gonatopsis*, *Histioteuthis*, and *Galiteuthis*] and octopus), other invertebrates, deep-sea fish, and other fish (lumpfish and redfishes). Most births occur in the summer and fall, but the reproductive rate for the sperm whale is low (Jefferson et al. 2015). Sperm whales may be found in the Pacific Northwest and Arctic proposed action areas only or encountered in transit between all proposed action areas as described in Appendix A.

<u>Subsistence and Whaling</u>

There are no reported takes of sperm whales by Native subsistence hunters in the proposed action areas. The IWC accorded sperm whales complete protection from commercial whaling by member states beginning with the 1981–1982 pelagic season and subsequently with the 1986 coastal season (IWC 1982). Currently, Japan takes a small number of sperm whales each year under an exemption for scientific research. Norway and Iceland have formally objected to the IWC ban on commercial whaling and are therefore free to resume whaling of sperm whales under IWC rules, but neither country has expressed an interest in taking sperm whales.

Northern Hemisphere

Sperm whale distribution is typically associated with waters over the continental shelf break, over the continental slope, and into deeper waters (Rice 1989; Whitehead 2003). Sperm whales are widely distributed across the entire North Pacific and into the southern Bering Sea in summer, but the majority are thought to be south of 40° N in winter (Gosho et al. 1984; Miyashita et al. 1995; Rice 1974; Rice 1989). The northernmost boundary of their range extends from Cape Navarin (62° N) across the Bering Sea to the Pribilof Islands (Omura 1955). Surveys conducted between 2001 and 2006 during summer have found sperm whales to be the most frequently sighted large cetacean in the coastal waters around the central and western Aleutian Islands (Muto et al. 2017). Sperm whales also occupy the Gulf of Alaska and Aleutian Islands throughout the year although they appear to be more common in summer than in winter (Mellinger et al. 2004), which is consistent with the hypothesis that sperm whales migrate to higher latitudes in summer and migrate to lower latitudes in winter (Whitehead and Arnbom 1987). NMFS recognizes three MMPA stocks in U.S. EEZ waters in the Pacific: California/Oregon/Washington stock, Hawaii stock, and North Pacific stock and one stock in the Atlantic Ocean, the Western North Atlantic stock. The CA/OR/WA stock is the only stock likely to be present in the Pacific Northwest and Arctic proposed action areas. Sperm whales in the North Atlantic and the Northeast Pacific stock are discussed in Appendix A as species considered for “Transit Only.”

A striking feature of the sperm whale’s life history is the difference in migratory behavior between adult males and females. Typically, adult males move into the higher latitudes, and all age classes and both sexes range throughout tropical and temperate seas. Although females and young sperm whales were thought to remain in tropical and temperate waters year-round, Mizroch and Rice (2006) and Ivashchenko et al. (2014) showed that there were extensive catches of female sperm whales above 50° N in the western Bering Sea and in the western Aleutian Islands. Females and juveniles generally range no further north than about 50–51° N in the southern Gulf of Alaska (Berzin and Rovnin 1966). Mizroch and Rice (2013) also showed female movements into the Gulf of Alaska and western Aleutians. Males are found in the summer in the Gulf of Alaska, Bering Sea, and waters around the Aleutian Islands (Ivashchenko et al. 2014; Kasuya and Miyashita 1988; Mizroch and Rice 2013). However, there are areas where at least some individual males and females are present year-round in the higher latitudes (Mellinger et al. 2004). The northern limit of adult male sperm whales in the North Pacific Ocean is estimated to extend from Cape Navarin Russia, to the Pribilof Islands in the northeastern Bering Sea (Berzin and Rovnin 1966). Therefore, it is unlikely that sperm whales would be encountered in the Arctic proposed action area.

Estimates of sperm whale abundance in California, Oregon, and Washington waters out to 300 nm are available from a trend-model analysis of line-transect data collected from six surveys conducted from 1991 to 2008 (Moore and Barlow 2014), ranging between 2,000 and 3,000 animals. A reliable population abundance estimate is not available for the North Pacific stock and there are no available estimates for numbers of sperm whales in Alaska (Muto et al. 2017).

Southern Hemisphere

Although sperm whales are found in the Southern Hemisphere, they are not likely to occur in the Antarctic proposed action area, but may occur in the deeper waters in proximity to the Antarctic proposed action area. Sperm whales in the South Atlantic and the South Pacific are discussed in Appendix A, as species evaluated for “Transit Only.”

3.2.7.4.j Bearded seal

Two subspecies of bearded seal have been described: *Erignathus barbatus barbatus* from the Laptev Sea, Barents Sea, North Atlantic Ocean, and Hudson Bay (Rice 1998); and *E. b. nauticus* from the remaining portions of the Arctic Ocean and the Bering and Okhotsk seas (Heptner et al. 1976; Manning 1974; Ognev 1935; Scheffer 1958). The geographic distributions of these subspecies are not separated by conspicuous gaps, and there are regions of integrating generally described as somewhere along the northern Russian and central Canadian coasts. The subspecies *E. b. nauticus,* is further divided into an Okhotsk DPS and a Beringia DPS. The Beringia DPS, also considered the Alaska bearded seal stock under the MMPA, is the only subspecies whose distribution overlaps with the Arctic proposed action area. Therefore, bearded seals may only be encountered in the Arctic proposed action area.

On December 28, 2012, NMFS listed both the Okhotsk and the Beringia DPS as threatened under the ESA (77 FR 76740). On July 25, 2014, the U.S. District Court for the District of Alaska issued a memorandum decision in a lawsuit challenging the listing of bearded seals under the ESA, thus vacating the previous decision to list the Beringia DPS of bearded seals as threatened. On October 24, 2016, the Ninth Circuit Court of Appeals reversed the 2014 U.S. District Court for the District of Alaska's decision, thereby upholding the 2012 listing status of the Beringia DPS as threatened under the ESA. No critical habitat is currently designated for bearded seals, and no recovery plan has been published for this species.

Subsistence

Bearded seals are an important resource for Alaska Native subsistence hunters. Approximately 64 Alaska Native communities in western and northern Alaska, from Bristol Bay to the Beaufort Sea, regularly harvest ice seals (Ice Seal Committee 2016). Based on the harvest data from these 12 communities (Point Lay, Kivalina, Noatak, Buckland, Deering, Emmonak, Scammon Bay, Hooper Bay, Tununak, Quinhagak, Togiak, and Twin Hills), a minimum estimate of the average annual harvest of bearded seals in 2009–2013 is 441 seals (Muto et al. 2017). The Coast Guard would continue the established notification process with subsistence hunters to determine where hunts are taking place to avoid the areas during those times.

Northern Hemisphere

Bearded seals are a northern Arctic species with circumpolar distribution (Burns 1967; Burns 1981; Burns and Frost 1979; Clarke et al. 2013a; Fedoseev 1965; Johnson et al. 1966; Kelly 1988; Smith 1981). Their normal range extends from the Arctic Ocean (85° N) south to Sakhalin Island (45° N) in the Pacific and south to Hudson Bay (55° N) in the Atlantic (Allen 1880; King 1983; Ognev 1935). Beringia DPS bearded seals are widely distributed throughout the northern Bering, Chukchi, and Beaufort Seas and are most abundant north of the ice edge zone (MacIntyre et al. 2013). Bearded seals inhabit the seasonally ice-covered seas of the Northern Hemisphere, where they whelp and rear their pups and molt their coats on the ice in the spring and early summer. The overall summer distribution is quite broad, with seals rarely hauled out on land; some seals, mostly juveniles, may not follow the ice northward but instead remain near the coasts of the Bering and Chukchi Seas (Burns 1967; Burns 1981; Heptner et al. 1976; Nelson 1981). As the ice forms again in the fall and winter, most seals move south with the advancing ice edge through the Bering Strait into the Bering Sea where they spend the winter (Burns 1981; Burns and Frost 1979; Cameron and Boveng 2007; Cameron and Boveng 2009; Kelly 1988). This southward migration is less noticeable and predictable than the northward movements in late spring and early summer (Burns 1981; Burns and Frost 1979; Kelly 1988). During winter, the central and northern parts of the Bering Sea shelf have the highest densities of bearded seals (Braham et al. 1981; Burns 1981; Burns and Frost 1979; Fay 1974; Heptner et al. 1976; Nelson et al. 1984). In late winter and early spring, bearded seals are widely but not uniformly distributed in the broken, drifting pack ice ranging from the Chukchi Sea south to the ice front in the Bering Sea. In these areas, they tend to avoid the coasts and areas of fast ice (Burns 1967; Burns and Frost 1979).

At present, reliable data on trends in population abundance for the Alaska stock of bearded seals are unavailable, but using a very limited sub-sample of the data collected from the U.S. portion of the Bering Sea in 2012, Muto et al. (2017) calculated an abundance estimate of approximately 299,174 (95% Confidence Interval= 245,476-360,544) bearded seals in those waters. These data do not include bearded seals in the Chukchi and Beaufort Seas.

Bearded seals along the Alaskan coast tend to prefer areas where sea ice covers 70 to 90 percent of the surface, and are most abundant 20–100 nm offshore during the spring season (Bengtson et al. 2000; Bengtson et al. 2005; Simpkins et al. 2003). In spring, bearded seals may also concentrate in nearshore pack ice habitats, where females give birth on the most stable areas of ice (Reeves et al. 2002). Bearded seals haul out on spring pack ice (Simpkins et al. 2003) and generally prefer to be near polynyas and other natural openings in the sea ice for breathing, hauling out, and prey access (Nelson et al. 1984; Stirling 1997). While molting between April and August, bearded seals spend substantially more time hauled out then at other times of the year (Reeves et al. 2002). Throughout the colder season, bearded seals move away from shore (Burns 1967). Bearded seals hunt on the seafloor in the shallow continental shelf areas of the Arctic. Their diet mainly consists of crabs, shrimp, mollusks, arctic and saffron cod, flatfish, sculpins, and octopus. They may also eat marine algae in some regions.

Southern Hemisphere

Bearded seals are not found in the Southern Hemisphere.

3.2.7.4.k Ringed seal

Most taxonomists currently recognize five subspecies of ringed seals: *Phoca hispida hispida* in the Arctic Ocean and Bering Sea; *P.h. ochotensis* in the Sea of Okhotsk and northern Sea of Japan; *P.h. botnica* in the northern Baltic Sea; *P. h. lagodensis* in Lake Ladoga, Russia; and *P. h. saimensis* in Lake Saimaa, Finland. For the purposes of this analysis, only the Arctic subspecies (*P.h. hispida*) that occurs within the U.S. EEZ of the Beaufort, Chukchi, and Bering Seas overlaps with the Arctic proposed action area. Ringed seals have a circumpolar distribution throughout the Arctic Basin, Hudson Bay and Straits, and Bering, Okhotsk, and Baltic Seas. They are strongly correlated with pack and land-fast ice, and areas covered at least seasonally by ice. Nearly all ringed seals breed on fast ice, excavating lairs in snow, in pressure ridges, and in other snow covered features. Pupping generally occurs from March through April. Ringed seals would be found in the Arctic proposed action area.

Although the ringed seal Arctic subspecies, also considered the Alaska ringed seal stock under the MMPA, is not currently listed under the ESA, it was proposed for listing on December 10, 2010 (75 FR 77476). On July 25, 2014, the U.S. District Court for the District of Alaska issued a memorandum decision in a lawsuit challenging the listing of ringed seals under the ESA, thus vacating the previous decision to list the Arctic subspecies of ringed seals as a threatened species. On October 17, 2016, the Ninth Circuit Court of Appeals concluded that the District Court's decision should be reversed and NMFS' decision to list the Arctic ringed seal should be upheld. On November 1, 2016, the Intervenor-Defendant requested that the Court reverse the District Court's judgment and uphold NMFS' rule to list the Arctic subspecies of ringed seal as threatened under the ESA. On February 12, 2018, in *Alaska Oil & Gas Association v. National Marine Fisheries Service* (Case No. 16-35380), the U.S. Court of Appeals for the Ninth Circuit reversed the 2016 decision that vacated a final regulation listing the Arctic subspecies of ringed seal as threatened. Therefore, the Coast Guard considered the Arctic subspecies of ringed seal as threatened under the ESA for the purposes of this analysis. NMFS proposed to designate critical habitat for the Arctic subspecies of the ringed seal (79 FR 71714; December 3, 2014), and no recovery plan has been published for this species. Critical habitat would include all the contiguous marine waters from the coastline of Alaska to an offshore limit within the U.S. EEZ. Critical habitat for the ringed seal would be within the proposed action area (Figure 3-13).

Subsistence

Ringed seals are hunted by Alaska coastal Natives from Bristol Bay to Kaktovik for food and oil. Current harvest is unknown, but indications are that although the harvest is substantial, it is sustainable and harvest was not considered to be a factor in the pending ESA action to list the species as threatened (Muto et al. 2017). The Ice Seal Committee and the ADFG survey a sample of coastal villages to document and monitor the harvest of ringed seals.

Northern Hemisphere

Ringed seals have a wide distribution in seasonally and permanently ice-covered waters, have an affinity for ice-covered waters, and are well adapted to occupying both shorefast and pack ice (Kelly 1988). They remain in contact with the ice most of the year and use it as a platform for pupping and nursing in late winter to early spring, for molting in late spring to early summer, and for resting at other times of the year. These small seals construct, maintain, and defend breathing holes and subnivean lairs in seasonally ice-covered waters.

Ringed seals have at least two distinct types of subnivean lairs: haulout lairs and birthing lairs (Smith and Stirling 1975). Haulout lairs are typically single-chambered and offer protection from predators and cold. Birthing lairs are larger, multi-chambered areas that are used for pupping in addition to protection from predators. 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). Most ringed seals are born in early April and about a month after parturition, mating begins in late April and early May. Ringed seals are expected in the proposed action area year-round, but during the Arctic summer months, from May to September, pupping would not occur and subnivean lairs would not be occupied.

Ringed seals rarely come ashore in the Arctic. In Alaska 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 1988). Although details of their seasonal movements have not been adequately documented, it is thought that most ringed seals that winter in the Bering and Chukchi Seas migrate north in spring as the seasonal ice melts and retreats (Burns 1970), and spend summers in the pack ice of the northern Chukchi and Beaufort Seas, as well as in nearshore ice remnants in the Beaufort Sea (Frost 1985). During summer, ringed seals range hundreds to thousands of kilometers to forage along ice edges or in highly productive open-water areas (Freitas et al. 2008; Harwood et al. 2015; Harwood and Stirling 1992; Kelly et al. 2010). With the onset of freeze-up in the fall, ringed seal movements become increasingly restricted. Seals that have summered in the Beaufort Sea are thought to move west and south with the advancing ice pack, with many seals dispersing throughout the Chukchi and Bering Seas while some remain in the Beaufort Sea (Crawford et al. 2012; Frost and Lowry 1984; Harwood et al. 2012). Some adult ringed seals return to the same small home ranges they occupied during the previous winter (Kelly et al. 2010).

Ringed seal population surveys in Alaska have used various methods and assumptions, had incomplete coverage of their habitats and range, and were conducted more than a decade ago; therefore, current, comprehensive, and reliable abundance estimates or trends for the Alaska stock are not available (Muto et al. 2017). During April-May in 2012 and 2013, U.S. and Russian researchers conducted comprehensive and synoptic aerial abundance and distribution surveys of ice-associated seals in the Bering and Okhotsk Seas (Moreland et al. 2013). Preliminary analysis of the U.S. surveys, which included only a small subset of the 2012 data, produced an estimate of about 170,000 ringed seals in the U.S. EEZ of the Bering Sea in late April (Conn et al. 2014). This estimate does not account for availability bias, thus the actual number of ringed seals is likely much higher, perhaps by a factor of two or more. The full data sets are currently being processed and analyzed to provide abundance estimates for ringed seals in the Bering and Okhotsk Seas (Muto et al. 2017).

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

Southern Hemisphere

Ringed seals are not found in the Southern Hemisphere.

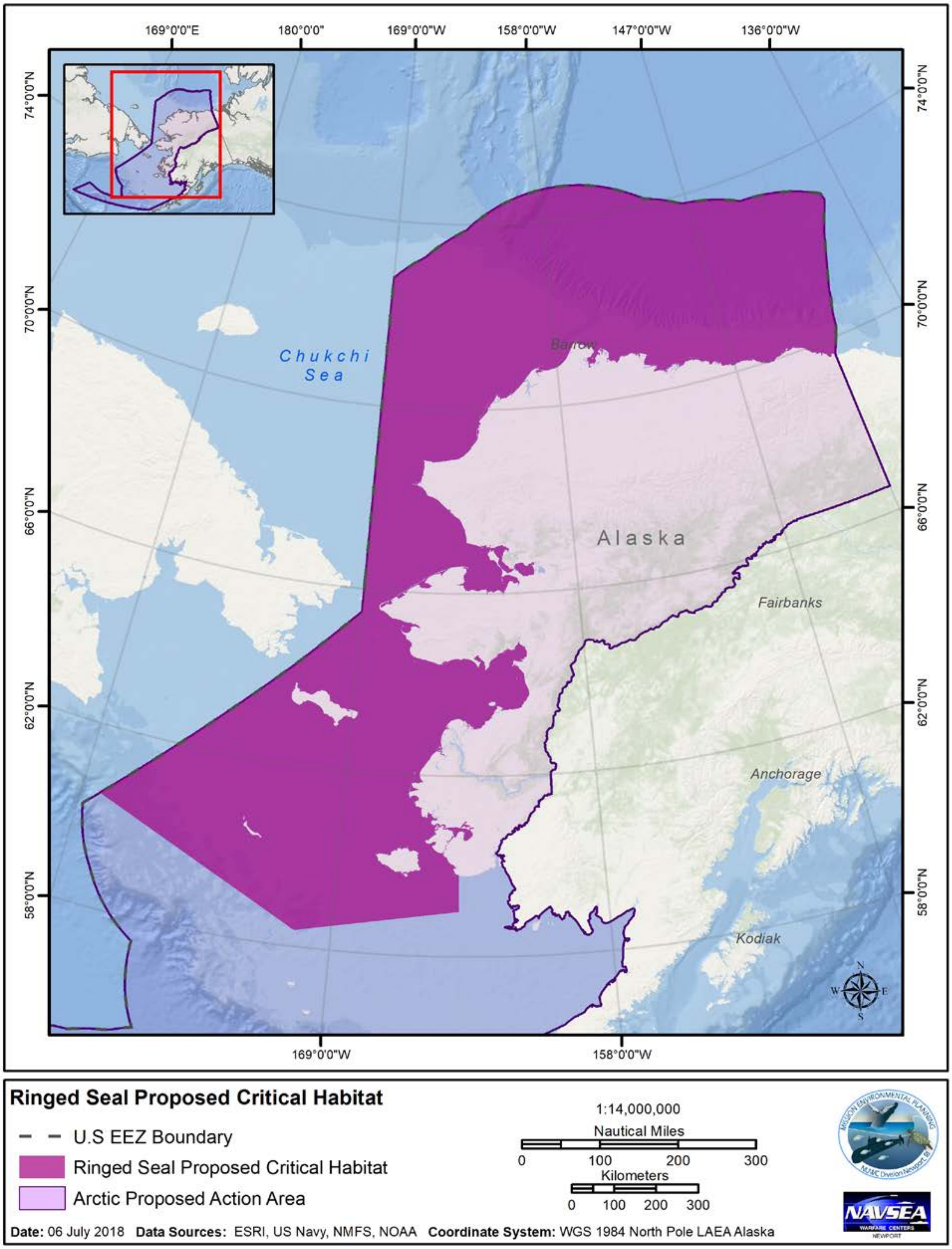


Figure 3-13. Proposed Ringed Seal Critical Habitat in the Arctic Proposed Action Area

3.2.7.4.l Steller sea lion

The Steller sea lion (*Eumetopias jubatus*) is the largest otariid and shows marked sexual dimorphism with males larger than females. Steller sea lions would be expected in the Pacific Northwest and Arctic proposed action areas. The Steller sea lion was listed as a threatened species under the ESA (55 FR 126451; April 5, 1990) due to substantial declines in the western portion of the range. Critical habitat was designated in 1993 (58 FR 45269; August 27, 1993). In 1997, NMFS designated two DPSs of Steller sea lions under the ESA: a western DPS and an eastern DPS (62 FR 24345, 62 FR 30772). Due to persistent decline, the western DPS was reclassified as endangered, while the increasing eastern DPS remained classified as threatened. In 2013, the eastern DPS was delisted (78 FR 66140) under the ESA. NMFS published a recovery plan in 1992, which was revised in 2008 (NMFS 1992, 2008b). Critical habitat is still designated for both DPSs, but only critical habitat within the Alaska/Arctic region overlaps with the Proposed Action (Figure 3-14).

In Alaska, the western DPS generally occurs west of Cape Suckling, Alaska (144° W longitude) and the eastern DPS generally occurs east of Cape Suckling. Critical habitat extends 3,000 ft (915 m) landward, an air zone that extends 3,000 ft (915 m) above, and an aquatic zone that extends 3,000 ft (915 m) seaward of each major rookery and haulout. Critical habitat also includes an aquatic zone that extends 20 nm seaward in State and federally managed waters from each major rookery and haulout. Large movements by individual Steller sea lions occur, and western DPS individuals are expected to occur in Southeast Alaska north of Sumner Strait (Jemison et al. 2013; NMFS 2013b).

<u>Subsistence</u>

Information on the subsistence harvest of Steller sea lions comes via two sources: the ADFG and the Ecosystem Conservation Office of the Aleut Community of St. Paul. The mean annual subsistence take from this stock for all areas except St. Paul in 2004–2008 (172), combined with the mean annual take for St. Paul in 2010–2014 (29), was 201 Steller sea lions from the western DPS (Muto et al. 2017).

Northern Hemisphere

The present range of Steller sea lions extends around the North Pacific Ocean rim from northern Japan; the Kuril Islands and Okhotsk Sea; through the Aleutian Islands and Bering Sea; along Alaska's southern coast; and south to California (Burkanov and Loughlin 2005; Kenyon and Rice 1961; Loughlin et al. 1992; Loughlin et al. 1984), with centers of abundance and distribution in the Gulf of Alaska and Aleutian Islands. Most adult Steller sea lions occupy rookeries during the pupping and breeding season, which extends from late May to early July (Gisiner 1985; Pitcher and Calkins 1981). As a result, peak abundance occurs during the summer breeding season. Major haulout sites and rookeries are centered in the Aleutian Islands and at islands and mainland sites in the Gulf of Alaska (Loughlin et al. 1984). Seal Rocks, which is near the entrance to Prince William Sound, is the northernmost rookery while Año Nuevo Island off central California is the southernmost rookery (37°06' N). Steller sea lions from the western DPS breed on the Pribilof and Aleutian Islands (Schusterman 1981). Steller sea lions that breed in Asia are considered part of the western DPS (Muto et al. 2017).

Steller sea lions are not known to migrate annually, but individuals may widely disperse outside of the breeding season (late-May to early-July) (Jemison et al. 2013; Muto et al. 2017). Colonization events in the northern part of the eastern DPS indicate movement of western sea lions into this area, but the mixed part of the range remains small (Jemison et al. 2013), and the overall discreteness of the eastern from the western stock remains distinct. The western stock of Steller sea lions decreased from an estimated 220,000–265,000 animals in the late 1970s to less than 50,000 in 2000 (Burkanov and Loughlin 2005; Loughlin et al. 1984; Loughlin and York 2000). Since 2000, the abundance of the western stock has increased, but there has been considerable regional variation in trend (Burkanov and Loughlin 2005; Fritz et al. 2013; Sease and Gudmundson 2002). Western Steller sea lion pup and non-pup counts in Alaska in 2014 were estimated to be 12,189 (90% credible interval: 11,318–13,064) and 37,308 (34,373–40,314), respectively (Johnson and Fritz 2014) and 2013–2014 survey results (DeMaster 2014; Fritz et al. 2013). Methods used to survey Steller sea lions in Russia differ from those used in Alaska, but the most recent counts of non-pup Steller sea lions in Russia were conducted in 2007–2011 and totaled approximately 12,700 and 6,021 pups (Muto et al. 2017).

Steller sea lions are widely distributed along the shelf break and coastal waters but are also found offshore in waters greater than 6,562 ft (2,000 m) deep (Bonnell et al. 1983; Fiscus 1983; Kajimura and Loughlin 1988; Kenyon and Rice 1961). Large numbers of individuals disperse widely outside of the breeding season (late May–early July), to access seasonally important prey resources. This results in marked seasonal patterns of abundance in some parts of the range and potential for intermixing in foraging areas of animals that were born in different areas (Sease and York 2003). Foraging habitat is primarily shallow, nearshore, and continental shelf waters (Reeves et al. 1992; Robson 2002). Steller sea lions often feed 4 to 13 nm offshore on a variety of fish species such as capelin, cod, herring, mackerel, pollock, rockfish, salmon, and sand lance (Fiscus et al. 1976). They also prey upon squid, octopus, bivalves, and gastropods.

Southern Hemisphere

The Steller sea lion is not found in the Southern Hemisphere.

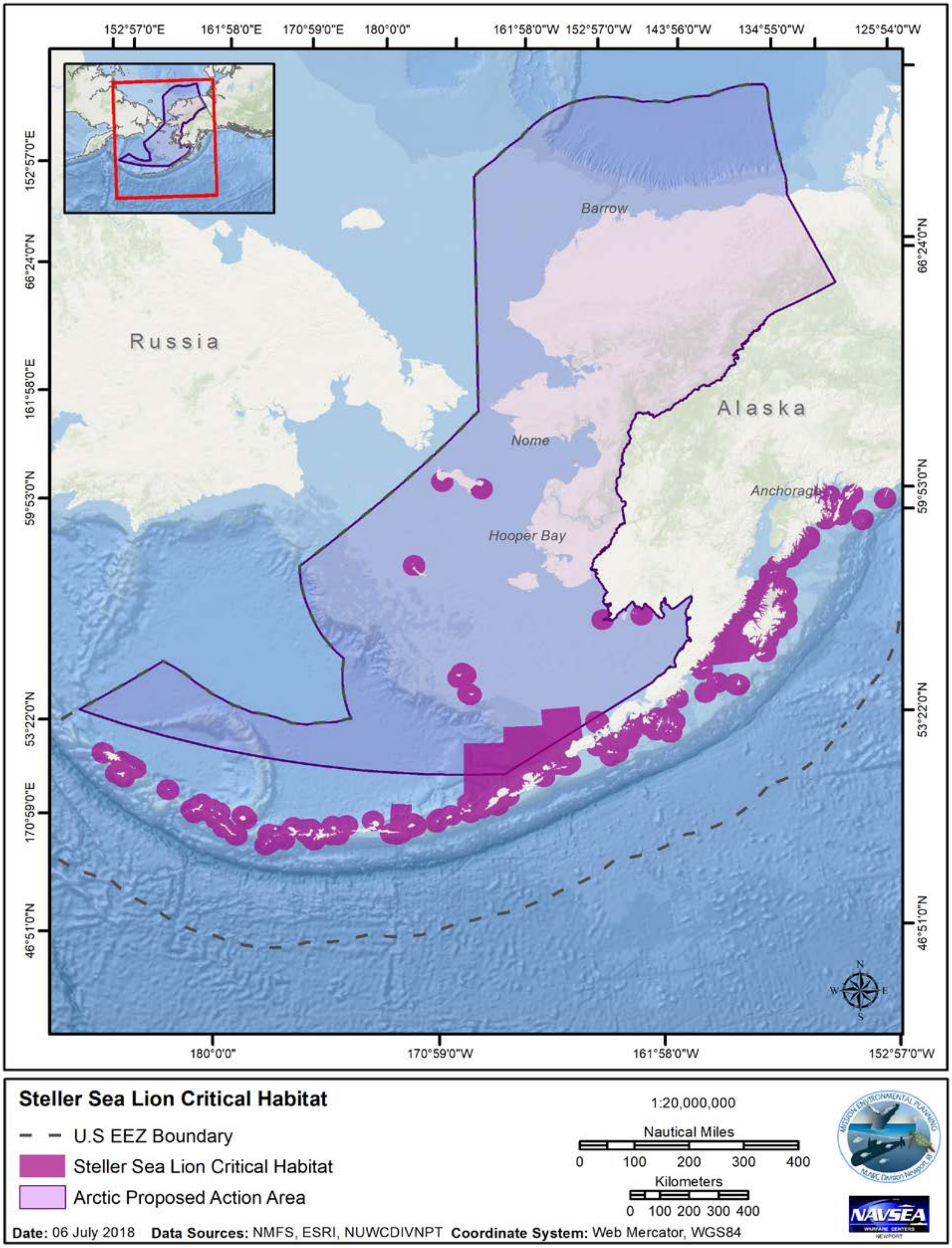


Figure 3-14. Steller Sea Lion Critical Habitat in the Arctic Proposed Action Area

3.2.7.4.m Sea otter

The sea otter (*Enhydra lutris*) is the largest of the mustelid family, but one of the smallest marine mammals. After a systematic review and analysis of skull morphology, Wilson et al. (1991) concluded there are three subspecies, *E. lutris lutris* from Asia to the Commander Islands, *E. l. nereis* from California, and *E. l. kenyoni* from Alaska. Currently, USFWS recognizes three stocks of sea otters in Alaska: southeast Alaska, southcentral Alaska, and southwest Alaska stocks (Gorbics and Bodkin 2001) and one stock in in California: the southern sea otter. The southern sea otter (*E.l. nereis*) is listed as threatened under the ESA and is therefore recognized as depleted under the MMPA. In 2005, the USFWS listed the southwest Alaska population (Alaska DPS) of northern sea otters (*E. lutris kenyoni*) as threatened under the ESA (70 FR 46366) and is therefore recognized as depleted under the MMPA. Critical habitat was designated in 2009 (74 FR 51988) for the northern sea otter and includes 5,855 mi^2 (15,164 km^2) from west to east: (1) Western Aleutian Unit; (2) Eastern Aleutian Unit; (3) South Alaska Peninsula Unit; (4) Bristol Bay Unit, and (5) Kodiak, Kamishak, Alaska Peninsula Unit. Within these five discrete units, critical habitat occurs in nearshore marine waters ranging from the mean high tide line seaward for a distance of 328 ft (100 m), or to a water depth of 65 ft (20 m). *E.l. lutris* is not listed under the ESA. Critical habitat for the sea otter does not overlap with the Arctic proposed action area (Figure 3-15); however, designated critical habitat may overlap with proposed vessel noise and movement and is further discussed in Section 4.2.1 and Appendix A. Recovery plans were published in 1982 and revised in 2003 for the southern sea otter (USFWS 2003) and in 2013 for the northern sea otter (USFWS 2013b). Non ESA-listed sea otters may be encountered during vessel transit and are discussed in Appendix A. ESA-listed sea otters are not expected in any of the proposed action areas, as discussed below.

<u>Subsistence</u>

Data for subsistence harvest of sea otters in Southeast Alaska are collected by a mandatory Marking, Tagging and Reporting Program administered by the USFWS since 1988. The mean reported annual subsistence take from Southeast Alaska during the past five complete calendar years (2006–2010) was 447 animals (Muto et al. 2017). This is an increase from the annual average of 322 sea otters hunted during the previous five-year period. Unlawful takes also occur and records are maintained by the USFWS.

Northern Hemisphere

About 90 percent of the world's sea otters live in coastal Alaska (USFWS 2013b). The southern sea otter population ranges between Half Moon Bay and Point Conception along the coast of central and southern California and is therefore outside of the Pacific Northwest proposed action area. The southwest Alaska DPS of the northern sea otter range is from the end of the Aleutian Islands to lower western Cook Inlet, and includes the Kodiak Archipelago and is therefore outside of the Arctic proposed action area. The current total population abundance estimate for the northern sea otter is 15,090 (Muto et al. 2017).

Southern Hemisphere

Northern sea otters are not found in the Southern Hemisphere.

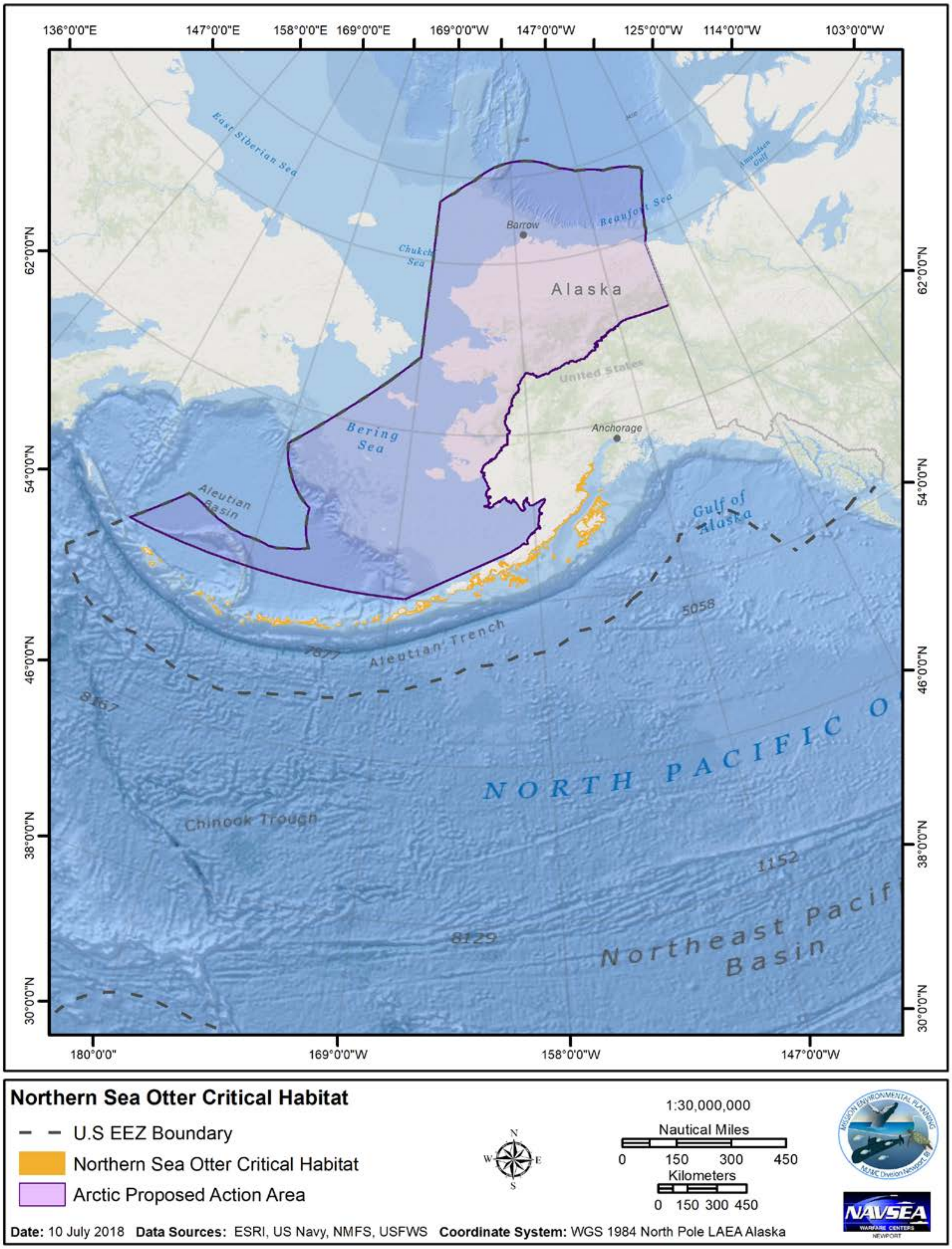


Figure 3-15. Northern Sea Otter Critical Habitat in the Arctic Proposed Action Area

3.2.7.4.n Polar bear

The polar bear (*Ursus maritimus*) belongs to the Order Carnivora and is a member of the bear Family Ursidae. There are two polar bear populations that occur in U.S. territory: the Chukchi Sea population and the Southern Beaufort Sea population. The USFWS designated the polar bear as threatened throughout its range under the ESA (73 FR 28212; May 15, 2008). Designated critical habitat for the polar bear (75 FR 76085; December 7, 2010) encompasses three areas or units: barrier islands, sea ice, and terrestrial denning habitat. The total area designated covers 187,157 mi^2 (484,734 km^2) (Figure 3-16). About 96 percent of the designated critical habitat area is sea ice. In 2016, USFWS released the final conservation management plan for the polar bear (USFWS 2016). Polar bears would be expected in the Arctic proposed action area as discussed below and encountered during vessel transit, as discussed in Appendix A.

<u>Subsistence</u>

Historically, polar bears have been killed for subsistence, handicrafts, and recreation. Based on records of skins shipped from Alaska from 1925–53, the estimated annual statewide harvest averaged 120 bears, taken primarily by Native hunters. Recreational hunting by non-native sports hunters using aircraft was common from 1951–72, increasing statewide annual harvest to 150 during 1951–60 and to 260 during 1960–72 (Amstrup et al. 1986; Schliebe et al. 1995). Hunting by non-Natives has been prohibited since 1973 when provisions of the MMPA went into effect. Under the MMPA, an exemption was made for Alaska Natives living in coastal communities to allow them to hunt polar bears for subsistence and making of handicrafts provided that the hunt was not done in a wasteful manner. Recently, harvest levels by Alaska Natives from the Chukchi/Bering Seas stock have been declining. The number of unreported kills in Alaska since 1980 to the present time is approximately 7 percent. No user agreement, similar to that between the Inuvialuit and Inupiat for the Beaufort Sea stock, exists for the Bering/Chukchi stock. Harvest levels are not limited at this time (Muto et al. 2017).

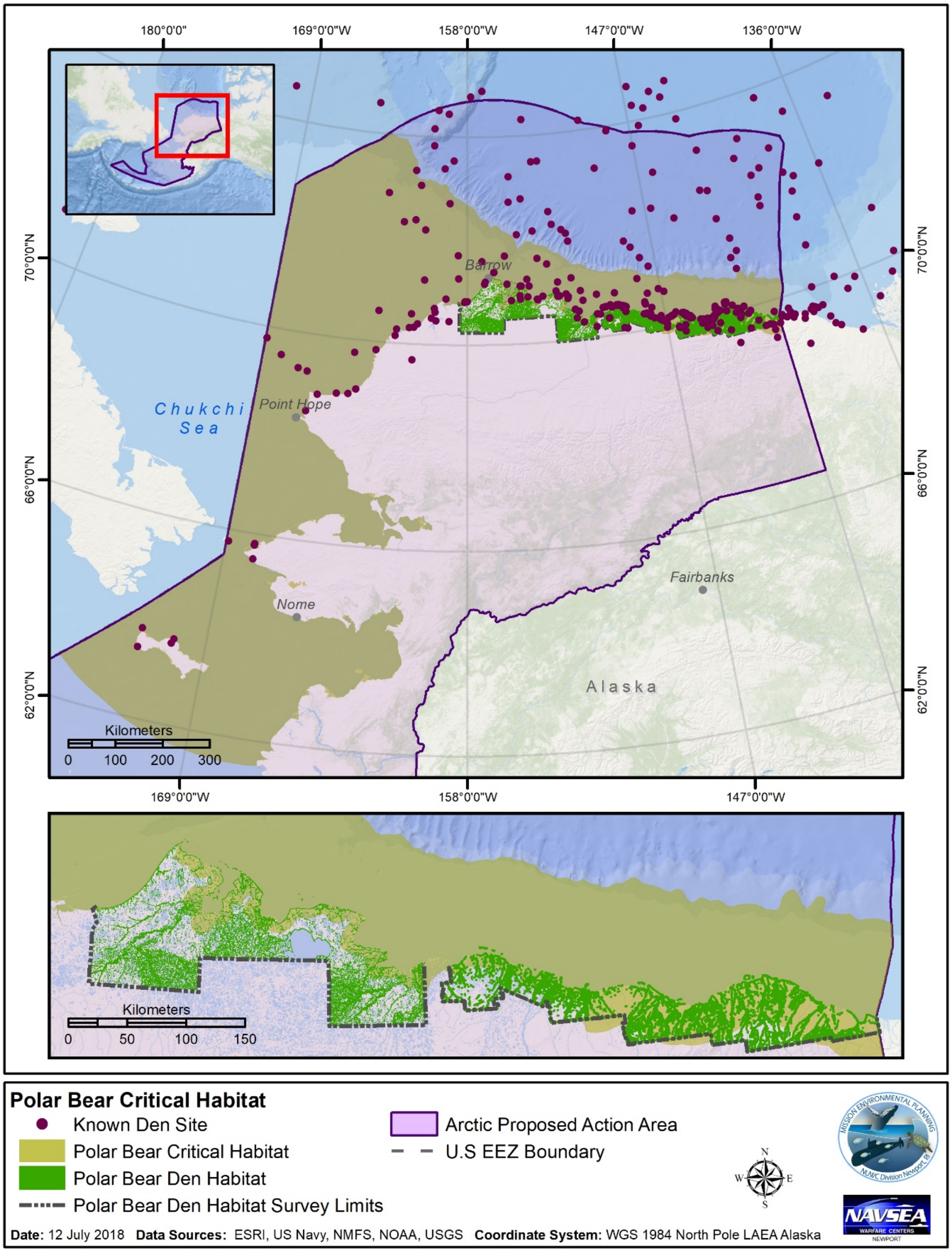
Northern Hemisphere

Polar bears are circumpolar in their distribution in the Northern Hemisphere; they occur in several largely discrete stocks or populations (Harington 1968). Polar bear movements are extensive and individual activity areas are enormous (Amstrup et al. 2000; Garner et al. 1990). It has been difficult to obtain a reliable population estimate for this population due to the vast and inaccessible nature of the habitat, movement of bears across international boundaries, logistical constraints of conducting studies in Russian territory, and budget limitations (Amstrup and DeMaster 1988; Evans et al. 2003; Garner et al. 1992; Garner et al. 1998). The Chukchi Sea population is estimated to comprise 2,000 animals, based on extrapolation of aerial den surveys (Lunn et al. 2002). Research on the Southern Beaufort Sea population began in 1967 and is one of only four polar bear populations with long term (>20 yrs) data. The population estimate of 1,526 (95% Confidence Interval=1211−1841; CV= 0.106) (Regehr et al. 2006), based on open population capture-recapture data collected from 2001 to 2006, is considered the most current and valid population estimate (Muto et al. 2017).

The Chukchi/Bering Sea stock is widely distributed on the pack ice in the Chukchi Sea and northern Bering Sea and adjacent coastal areas in Alaska and Russia. The northeastern boundary of the Chukchi/Bering Seas stock is near the Colville Delta in the central Beaufort Sea (Amstrup 1995; Amstrup et al. 2005; Garner et al. 1990), and the western boundary is near Chauniskaya Bay in the eastern Siberian Sea. The southern boundary of the Chukchi/Bering Sea stock extends into the Bering Sea and is determined by the annual extent of pack ice (Garner et al. 1990). Historically, polar bears ranged as far south as St. Matthew Island (Hanna 1920) and the Pribilof Islands (Ray 1971) in the Bering Sea. An extensive area of overlap between the Southern Beaufort Sea stock and the Chukchi/Bering Seas stock occurs between Point Barrow and Point Hope, centered near Point Lay (Amstrup et al. 2000; Garner et al. 1994; Garner et al. 1990).

The Southern Beaufort Sea population spends the summer on pack ice and moves toward the coast during fall, winter, and spring (Durner et al. 2004). Polar bears in the Southern Beaufort Sea concentrate in shallow 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, in order to access prey such as ringed and bearded seals (Amstrup et al. 2000; Durner et al. 2006; Durner et al. 2009; Stirling et al. 1999). The eastern boundary of the Southern Beaufort Sea stock occurs south of Banks Island and east of the Baillie Islands, Canada (Amstrup et al. 2000). The western boundary of the Southern Beaufort Sea stock is near Point Hope, Alaska. Polar bears from this population have historically denned on both the sea ice and land. Therefore, the southern boundary of the Southern Beaufort Sea stock is defined by the limits of terrestrial denning sites inland of the coast, which follows the shoreline along the North Slope in Alaska and Canadian Arctic (Bethke et al. 1996). The main terrestrial denning areas for the Southern Beaufort Sea population in Alaska occur on the barrier islands from Barrow/Utqiagvik to Kaktovik and along coastal areas up to 25 mi (40 km) inland, including the Arctic National Wildlife Refuge to Peard Bay, west of Barrow/Utqiagvik (Amstrup et al. 2000; Amstrup and Gardner 1994; Durner et al. 2001; Durner et al. 2006). Mating occurs in late March through early May. In November and December, females dig maternity dens in fast ice, drifting pack ice, or land along the coast. Females give birth between December and January and stay in their dens with their cubs until spring (Reeves et al. 2002).

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



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2 **Figure 3-16. Polar Bear Critical Habitat and Known Den Sites in the Arctic Proposed Action**
3 **Area**

Southern Hemisphere

The polar bear is not found in the Southern Hemisphere.

3.2.7.5 Other (Non-ESA listed) Marine Mammals

Non-ESA listed marine mammals that may occur in the proposed action areas where either icebreaking (Antarctic and Arctic) or vessel performance evaluation and testing (Pacific Northwest) would take place are listed in Table 3-10. All other non-ESA listed marine mammal species that are not expected to be encountered in the proposed action areas, but may overlap with vessel transit, are discussed in Appendix A.

Table 3-10. Non-ESA listed Marine Mammal Species that May Occur in the Proposed Action Areas

Species (common name)	Proposed Action Area
Mysticete	
Gray whale (ENP stock)	Arctic, Pacific Northwest
Minke whale (common)	Pacific Northwest
Minke whale (Antarctic)	Antarctic
Odontocete	
Arnoux's beaked whale	Antarctic
Baird's beaked whale	Pacific Northwest
Beluga whale	Arctic
Blainville's beaked whale	Pacific Northwest (possible)
Cuvier's beaked whale	Pacific Northwest
Dall's porpoise	Arctic, Pacific Northwest
Dwarf sperm whale	Pacific Northwest
False killer whale	Pacific Northwest (possible)
Harbor porpoise	Arctic (possible), Pacific Northwest
Hourglass dolphin	Antarctic
Hubb's beaked whale	Pacific Northwest (possible)
Killer whale	Antarctic, Arctic (possible), Pacific Northwest
Narwhal	Arctic
Northern right whale dolphin	Pacific Northwest
Pacific white-sided dolphin	Pacific Northwest
Pygmy sperm whale	Pacific Northwest
Risso's dolphin	Pacific Northwest
Short-beaked common dolphin	Pacific Northwest
Short-finned pilot whale	Pacific Northwest (possible, but rare)
Southern bottlenose whale	Antarctica
Stejneger's beaked whale	Pacific Northwest (possible)
Striped dolphin	Pacific Northwest
Pinniped	
Antarctic fur seal	Antarctic (possible)
California sea lion	Pacific Northwest
Crabeater seal	Antarctic
Harbor seal	Pacific Northwest
Leopard seal	Antarctic
Northern elephant seal	Pacific Northwest

Species (common name)	Proposed Action Area
Northern fur seal	Pacific Northwest
Ribbon seal	Arctic (possible)
Southern elephant seal	Antarctic
Spotted seal	Arctic
Steller sea lion	Pacific Northwest
Walrus	Arctic
Weddell seal	Antarctic

3.2.7.5.a Non-ESA listed Mysticetes

The gray whale (ENP stock) and minke whale (common [*Balaenoptera acutorostrata*] and Antarctic [*B. bonaerensis*]) are the only non-ESA listed mysticetes likely to be in the proposed action areas.

i. Gray whale

Gray whales may be found in the Arctic Region (60° N latitude) and may overlap with the Arctic proposed action area. ENP gray whales would also be expected to overlap with the Pacific Northwest proposed action area. In general, gray whales from the ENP stock migrate between feeding grounds and breeding/calving sites through October-July (Calambokidis et al. 2015) (see Section 3.2.7.4.d) and, therefore, would not be expected to occur in either of the proposed action areas year-round. During summer and fall, most whales in the ENP population feed in the Chukchi, Beaufort and northwestern Bering Seas. An exception to this is the relatively small number of whales that summer and feed along the Pacific coast between Kodiak Island, Alaska and northern California (Calambokidis et al. 2012; Darling 1984; Gosho et al. 2011), referred to as the “Pacific Coast Feeding Group” (PCFG).

In 2010, the IWC’s Standing Working Group on Aboriginal Whaling Management Procedure agreed to designate animals that spend the summer and autumn feeding in coastal waters of the Pacific coast of North America from California to southeast Alaska as the PCFG (IWC 2012b). This definition was further refined for purposes of abundance estimation, limiting the geographic range to the area from northern California to northern British Columbia (from 41° N to 52° N), limiting the temporal range to the period from June 1 to November 30 and counting only those whales seen in more than one year within this geographic and temporal range (IWC 2012b). The IWC adopted this definition in 2011 but noted that “not all whales seen within the PCFG area at this time will be PCFG whales, and some PCFG whales will be found outside of the PCFG area at various times during the year” (IWC 2012b). The most recent estimate of abundance for the ENP population is 20,990 (CV=0.05) whales (Durban et al. 2013). The 2012 abundance estimate for the defined range of the PCFG between 41° N to 52° N is 209 animals (Standard Error=15.4; CV= 0.07).

ii. Minke whale

Common minke whales may be found in the Alaska Region (60° N latitude) during the summer and fall months (Alaska stock), though they are not expected in the Arctic proposed action area. Minke whales have a potential occurrence year-round in the Pacific Northwest proposed action area and would be from the CA/OR/WA stock. Common minke whales may also be encountered when the vessel is in transit. The Antarctic minke whale would only overlap with the Antarctic proposed action area, but it would also overlap with vessel transit.

Minke whales generally occupy waters over the continental shelf, including inshore bays and occasionally estuaries; however, records from whaling catches and research surveys worldwide indicate an open ocean component to the minke whale's distribution. In waters of the United States, minke whales are migratory and generally participate in annual movement between low-latitude breeding grounds in the winter and high-latitude feeding grounds in the summer (Kuker et al. 2005). They have been shown to follow patterns of prey availability (Jefferson et al. 2008). Minke whales from the CA/OR/WA stock are considered "residents" because they establish home ranges in the inland waters (Dorsey et al. 1990). No estimates have been made for the number of minke whales worldwide, nor are there estimates for the entire North Pacific. Forney (2007) estimated 957 (CV=1.36) during a 2005 ship survey off California, Oregon, and Washington, while the most recent survey in 2008 did not record any minke whales (Barlow 2010). Therefore, the number of minke whales off California, Oregon, and Washington is estimated to be the arithmetic mean of the two most recent ship line transect surveys conducted in 2005 and 2008 (Barlow 2010; Barlow and Forney 2007; Forney 2007), or 478 (CV=1.36) whales.

Antarctic minke whales occur widely in coastal and offshore areas of the Southern Hemisphere and are found from at least 70° S to the ice edges. Their range is generally thought to be circumpolar and is more oceanic than range of dwarf minke whales (unnamed subspecies). Not all Antarctic minke whales migrate, but there is a general shift northward for breeding in the winter months. Antarctic minke whales tend to be more polar than the common minke whale and spend most of their summers around the Antarctic continent. The IWC conducted a major assessment of Antarctic minke whales in 1990, and a population estimate of 760,000 was adopted (IWC 1991). Results of subsequent surveys indicated lower abundance estimates (Branch 2006; IWC 2007), but the IWC has not yet adopted a new population abundance estimate.

3.2.7.5.b Non-ESA listed Odontocetes

There are several non-ESA listed odontocetes whose distribution overlaps with the proposed action areas (Table 3-10), including beaked whales, beluga whales, narwhals, pilot whales, bottlenose whales, dwarf and pygmy sperm whales, dolphins, and porpoises. More information on the distribution, seasonality, and stock or DPS information for these species can be found in Section A.3 in Appendix A.

i. Beaked whales

In general, little is known about beaked whales, with the exception that they are thought to be deep divers.

The Arnoux's beaked whale (*Berardius arnuxii*) is believed to have a vast circumpolar distribution in deep, cold temperate and subpolar waters of the Southern Hemisphere. Most records of the whale are south of 40° S, but there are some records as far north as 24° S (Jefferson et al. 2015). The Arnoux beaked whale may overlap with the Antarctic proposed action area and other areas when the vessel is in transit.

Baird's beaked whale (*Berardius bairdii*) occurs mainly in deep waters over the continental slope, near oceanic seamounts, and areas with submarine escarpments, although they may be seen close to shore where deep water approaches the coast (Jefferson et al. 2008; Kasuya 2009). This species is generally found throughout the colder waters of the North Pacific, ranging from off Baja California, Mexico, to the Aleutian Islands of Alaska (Jefferson et al. 2008; MacLeod and D'Amico 2006). In the North Pacific, the range of Baird's beaked whale extends from Cape Navarin (62° N) and the central Sea of Okhotsk (57° N) to St. Matthew Island, the Pribilof Islands in the Bering Sea, and the northern Gulf of Alaska (Kasuya 2009; Muto et al. 2017; Rice 1998). The CA/OR/WA stock may overlap with the Pacific Northwest proposed action area and other areas when the vessel is in transit. The Alaska stock of Baird's beaked whales would only overlap with the vessel while in transit (see Appendix A).

Cuvier's beaked whale (*Ziphius cavirostris*) is widely distributed in offshore waters of all oceans, from the tropics to polar regions in both hemispheres. They are found in deep waters (>656 ft [200 m]) but prefer waters over and near the continental slope. Cuvier's beaked whales from the CA/OR/WA stock may overlap with the Pacific Northwest proposed action area and when the vessel is in transit. The Alaska stock of Cuvier's beaked whales would only overlap with the vessel while in transit (see Appendix A).

Southern bottlenose whales (*Hyperoodon planifrons*) have a circumpolar distribution in the Southern Hemisphere, south of about 30° S. There are known areas of concentration between 58° S and 62° S in the Atlantic and eastern Indian Ocean sections of their range. They do migrate and are found in Antarctic waters during the summer, where they occur within 75 mi (120 km) of the ice edge (Jefferson et al. 2015). Like other beaked whales, these deep water oceanic animals do not often stray beyond the continental shelf. The Southern bottlenose whale would overlap with the Antarctic proposed action area and vessel transit.

The following beaked whales may overlap with the Pacific Northwest proposed action area, but information regarding these species is poor or they are considered rare visitors to the Pacific Northwest proposed action area; they include: Blainville beaked whale (*Mesoplodon densirostris*), Hubb's beaked whale (*M. carlhubbsi*), and Stejneger's beaked whale (*M. stejnegeri*). Blainville beaked whales are typically found in temperate and tropical waters of all oceans, but mainly offshore. They may also occur in enclosed seas with deep waters. Hubb's beaked whales are limited to the North Pacific Ocean, ranging from central British Columbia to southern California in the east and Japan in the west. Stejneger's beaked whales appear to prefer cold temperate and subpolar waters (Loughlin and Perez 1985; MacLeod et al. 2006). This species has been observed in waters ranging in depth from 2,395 to 5,120 ft (730 to 1,560 m) on the steep slope of the continental shelf (Loughlin and Perez 1985). In addition to possible overlap with the Pacific Northwest proposed action area, all of the Mesoplodon species described above could be encountered when the vessel is in transit.

ii. Beluga and Narwhal

The beluga whale (*Delphinapterus leucas*) and narwhal (*Monodon monoceros*) belong to the family Monodontidae and inhabit high areas of the Northern Hemisphere but are restricted to the high latitude waters of the Arctic, often near or in iced areas. Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980); are closely associated with open leads and polynyas in ice-covered regions (Hazard 1988); and are often found in fjords, estuaries, and shallow waters of the Arctic. In the United States and Canada, individual populations have been assessed for status under the applicable conservation statutes.

Five stocks of beluga whales are recognized within U.S. waters: (1) Cook Inlet, (2) Bristol Bay, (3) Eastern Bering Sea, (4) Eastern Chukchi Sea, and (5) Beaufort Sea. Beaufort Sea, Eastern Chukchi Sea, Eastern Bering Sea, and Bristol Bay stocks of beluga whales are not listed as threatened or endangered under the ESA or listed as depleted or classified as strategic under the MMPA. Only the Cook Inlet DPS is listed as endangered under the ESA, but it does not occur in the proposed action areas. Critical habitat has been designated for the Cook Inlet beluga whale DPS, but the critical habitat does not occur in the Arctic proposed action area. Depending on season and region, beluga whales may occur in both offshore and coastal waters, with summer concentrations in upper Cook Inlet, Bristol Bay, the eastern Bering Sea (i.e., Yukon Delta, Norton Sound), eastern Chukchi Sea, and the Mackenzie Delta (Hazard 1988). During the winter, beluga whales occur in offshore waters associated with pack ice. In the spring, they migrate to warmer coastal estuaries, bays, and rivers where they may molt (Finley 1982; Suydam 2009) and give birth to and care for their calves (Sergeant and Brodie 1969). Annual migrations can range over thousands of kilometers (Richard et al. 2001). Beluga whales may be encountered in the Arctic proposed action area and during vessel transit.

Narwhals are common in the waters of Nunavut, Canada, west Greenland, and in the European Arctic; however, they rarely occur in the East Siberian, Bering, Chukchi, and Beaufort Seas (COSEWIC 2004). Narwhals are rare within the Arctic proposed action area, but extralimital sightings and stranding have occurred (COSEWIC 2004; Muto et al. 2016, 2017; Reeves and Tracy 1980). Therefore, narwhals may be encountered in the Arctic proposed action area and during vessel transit.

iii. Other whales (odontocetes)

Other whales that may be within the proposed action areas (Table 3-10) include the dwarf sperm whale (*Kogia sima*), pygmy sperm whale (*Kogia breviceps*), and short-finned pilot whale (*Globicephala macrorhynchus*). Both the dwarf and pygmy sperm whale could overlap with Pacific Northwest proposed action area; however, sightings have been very rare. Pygmy sperm whales are distributed throughout deep waters and along the continental slopes of the North Pacific and other ocean basins (Caldwell and Caldwell 1989; Ross 1984). Available data are insufficient to identify any seasonality in the distribution of the CA/OR/WA stock of pygmy sperm whales or to delineate possible stock boundaries. Along the U.S. West Coast, no at-sea sightings of dwarf pygmy sperm whales have been reported; however, this may be partially a reflection of their pelagic distribution, small body size, and cryptic behavior (Carretta et al. 2017). The CA/OR/WA stock of dwarf sperm whales and CA/OR/WA stock of pygmy sperm whales, although rare, could overlap with the Pacific Northwest proposed action area and with vessel transit.

The full geographic range of the California, Oregon, and Washington population of short-finned pilot whales is not known (Carretta et al. 2017). Short-finned pilot whales from the CA/OR/WA stock could overlap with the Pacific Northwest proposed action area and vessel transit, but sightings are very rare and dependent on oceanographic conditions (e.g., warmer waters); therefore, the likelihood that the short-finned pilot whale would overlap with the Pacific Northwest proposed action area is extremely low.

iv. Dolphins

Several dolphin species may be within the proposed action areas (Table 3-10) and they include the killer whale, Northern right whale dolphin (*Lissodelphis borealis*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), Risso's dolphin (*Grampus griseus*), short-beaked common dolphin (*Delphinus delphis*), and striped dolphin (*Stenella coeruleoalba*).

Killer whales are the largest of the dolphins with several geographic forms. They are the most cosmopolitan of all cetaceans and can be found in any marine region from the equator to ice edges, including enclosed seas. Killer whales could overlap with the Pacific Northwest and Antarctic proposed action areas. As ice conditions change in the Arctic, more killer whales have been observed traveling through the Bering Strait; however, at this time they are not expected to overlap with the Arctic proposed action area. They would overlap with vessel transit.

Killer whale ecotypes in Antarctica include Type A, B, C, and D (Gorter and Pitman 2011). Type A killer whales are found in all oceans and seas, up to ice edges but are more common in nearshore, cool temperate to subpolar waters. Type B are found mainly in the Antarctic and surrounding waters, often in pack ice (mainly near the Antarctic Peninsula). Type C (Ross Sea killer whales) are also an Antarctic form but prefer East Antarctica and are mainly found in pack ice. Type D is likely restricted to subantarctic waters. In the North Pacific the following killer whale forms are found: resident (preferred prey is fish, specifically salmon), transient (also known as Bigg's killer whales whose preferred prey is mammals), and offshore (preferred prey is sharks).

Currently, there are eight killer whale stocks recognized with the U.S. EEZ in the Pacific: (1) the Alaska Resident stock—occurring from southeastern Alaska to the Aleutian Islands and Bering Sea, (2) the Northern Resident stock— occurring from Washington State through part of southeastern Alaska, (3) the Southern Resident stock—occurring mainly within the inland waters of Washington State and southern British Columbia, but also in coastal waters from southeastern Alaska through California, (4) the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock—occurring mainly from Prince William Sound through the Aleutian Islands and Bering Sea, (5) the AT1 transient stock—occurring in Alaska from Prince William Sound through the Kenai Fjords, (6) the West Coast transient stock—occurring from California through southeastern Alaska, (7) the Offshore stock—occurring from California through Alaska, and (8) the Hawaiian stock. 'Transient' whales in Canadian waters are considered part of the West Coast Transient stock. All other killer whale stocks in the Northern Hemisphere are in Appendix A, as species evaluated for "Transit Only."

The Northern right whale dolphin is an oceanic species, inhabiting cool and warm temperate regions of the North Pacific. They are typically found between 30° N and 50° N, and the CA/OR/WA stock would therefore overlap with the Pacific Northwest proposed action area and vessel transit. Northern right whale dolphins are typically found in deeper waters from the continental shelf to oceanic regions. While their distribution varies based on oceanic conditions and seasons, typically their range stretches from northern Baja California, Mexico to British Columbia. Northern right whale dolphins move south during the colder fall and winter months and north during the spring and summer (Barlow 1995; Forney et al. 1995; Green et al. 1992; Green et al. 1993). Northern right whale dolphins from the CA/OR/WA stock would overlap with the Pacific Northwest proposed action area and vessel transit.

The Pacific white-sided dolphin inhabits cool temperate waters of the North Pacific and some adjacent seas (Japan, Okhotsk, southern Bering and southern Gulf of California). They are widely distributed in deep offshore waters, extending onto the continental shelf. Pacific white-sided dolphins also occur in some nearshore areas in the Pacific Northwest (e.g., Washington). Seasonal inshore/offshore and north/south movements have been documented (Jefferson et al. 2015). Largely pelagic, this species ranges from the Gulf of California to the Gulf of Alaska. In Alaska, this species is common both on the high seas and along the continental margins, and animals are known to enter inshore passes (Carretta et al. 2017; Ferrero and Walker 1996). For the CA/OR/WA stock, patterns from aerial and shipboard surveys (Barlow 1995; Forney et al. 1995; Green et al. 1992; Green et al. 1993) suggest seasonal north-south movements, with animals found primarily off California during the colder water months, and shifting northward into Oregon and Washington as water temperatures increase in late spring and summer (Forney 1994; Green et al. 1992). Pacific white-sided dolphins would overlap with the Pacific Northwest proposed action area and vessel transit would overlap with the Alaska stock, as well.

Risso's dolphins are commonly seen on the continental shelf and in slope and offshore waters of California, Oregon, and Washington (Carretta et al. 2017). Risso's dolphins appear to strongly favor waters on the continental shelf and slope, as opposed to deep waters of the oceanic zones, although they can occur in deeper water at lower densities (Jefferson et al. 2015; Soldevilla et al. 2009). In a review of the distribution data on Risso's dolphins, Jefferson et al. (2015) found southeastern Alaska to be the northernmost extent of their range. However, this review determined that even though suitable habitat might appear to exist, there is little evidence that Risso's dolphins normally inhabit the deep inshore waters of Alaska; thus, the few sightings there are considered extralimital. Although their distribution is from latitudes 60° N to 60° S, Risso's dolphins appear to favor mid-latitudes ranging from latitudes 30° N to 45° S (Carretta et al. 2017; Muto et al. 2017). These latitudes are where the species' highest densities are consistently found in most ocean basins, including the Pacific Ocean (Jefferson et al. 2015). Therefore, Risso's dolphins from the CA/OR/WA stock would overlap with the Pacific Northwest proposed action area and vessel transit.

The majority of short-beaked common dolphin populations are found off of California, especially during summer and fall. Short-beaked common dolphins prefer warm tropical to cool temperate waters that are primarily oceanic and offshore, with depths between 656 and 6,562 ft (200 and 2,000 m) (Bearzi et al. 2005; Jefferson et al. 2008; Reeves et al. 2002). Depending on oceanographic conditions (e.g., warmer water), the likelihood that short-beaked common dolphins would overlap with the Pacific Northwest proposed action area is extremely low; however, they could be encountered during vessel transit.

Striped dolphins are widely distributed in the Atlantic, Pacific, Indian Oceans, and adjacent seas. They prefer primarily warm waters and their range is limited to 50° N and 40° S. The CA/OR/WA stock may overlap with the Pacific Northwest proposed action area as animals have stranded in Oregon and Washington, although no sightings have been observed off Washington. Therefore, the likelihood that striped dolphins would overlap with the Pacific Northwest proposed action area is extremely low, but they could be encountered during vessel transit.

v. Porpoises

Porpoises that may be within the proposed action areas (Table 3-10) include the Dall's porpoise (*Phocoenoides dalli*) and harbor porpoise (*Phocoena phocoena*). Dall's porpoise is found only in the North Pacific Ocean, Bering Sea, Okhotsk Sea, and Sea of Japan. They inhabit deep waters of the warm temperate through subarctic zones, between 30 and 62° N. During unusual cold periods, Dall's porpoise may range as far as 28° N. They typically occur offshore in oceanic zones, but approach nearshore areas where the deep water approaches the coast. Therefore, Dall's porpoise from the CA/OR/WA stock would be expected to overlap with the Pacific Northwest proposed action area and vessel transit. The Alaska stock of Dall's porpoise would also overlap with vessel transit, but would not overlap with the Arctic proposed action area.

Harbor porpoises are generally found in cool temperate to subarctic waters over the continental shelf, occurring most frequently in waters less than 328 ft (100 m) deep (Hobbs and Waite 2010). In the eastern North Pacific Ocean, harbor porpoises range from northern Honshu, Japan to Point Barrow, along the Alaska coast, and down the West Coast of North America to Point Conception, California (Gaskin 1984). In Alaskan waters, harbor porpoises inhabit nearshore areas and are common in bays, estuaries, and tidal channels, and may be found year-round. The Northern Oregon/Washington and Washington Inland waters stocks may overlap with the Pacific Northwest proposed action area and vessel transit. In addition, the Bering Sea stock may also overlap with vessel transit, but harbor porpoises would not be expected to overlap with the Arctic proposed action area.

3.2.7.5.c Non-ESA listed Pinnipeds and Sea Otters

There are several non-ESA listed pinnipeds whose distribution overlaps with the proposed action areas (Table 3-10), including the California sea lion, harbor seal, leopard seal, Northern elephant seal, Northern fur seal, ribbon seal, spotted seal, and Weddell seal; northern and southern sea otters are distributed in areas of vessel transit. More information on the distribution, seasonality, and stock or DPS information for these species can be found in Section A.3 in Appendix A.

i. California sea lion

California sea lions (*Zalophus californianus*) occur in eastern North Pacific from Tres Marias Islands (Mexico), through the Gulf of Mexico, around the end of Baja California and north to the Gulf of Alaska. Most rookeries are south of Point Conception, California. Pupping and breeding take place from May through July on the offshore islands (e.g., Channel Islands). Sea lions are found in waters over the continental shelf and slope and occupy several landfalls offshore in deep oceanic areas. There is a post-breeding migration (mainly juveniles and sub/adult males) north from the major rookeries in the southern portion of its range to winter from Central California to Washington. Smaller numbers migrate farther to British Columbia and Gulf of Alaska. They frequent bays, harbors, river mouths, and often haul out on buoys, jetties, boat docks, and other manmade objects. The U.S. stock of California sea lions would likely overlap with the Pacific Northwest proposed action area and vessel transit.

ii. Harbor seal

Harbor seals (*Phoca vitulina*) are typically confined to coastal areas of the Northern Hemisphere, from temperate to Polar Regions. There are currently five subspecies of harbor seal recognized worldwide. Harbor seals are found in coastal waters of continental shelf and slope, common in bays, rivers, estuaries, and intertidal areas. They are considered essentially non-migratory, but do make foraging trips and certain age classes (e.g., juveniles) are known to travel far from their natal breeding areas. Mating takes place during the February to October breeding season and pupping occurs sometime between April and July. Breeding/pupping season is clinal and dependent on location (occurs earlier in southern areas of a given population’s range). The Oregon/Washington stock and Washington Inland stock would overlap with the Pacific Northwest proposed action area and vessel transit. The Alaska stock would only overlap vessel transit.

iii. Leopard seal

The leopard seal (*Hydrurga leptonyx)* is widely distributed in the cold Antarctic and subantarctic waters of the Southern Hemisphere (50° S to 80° S), from the coast of the continent north through the pack ice, and most subantarctic islands. Leopard seals haul out on land and ice, but prefer ice floes found nearshore. Pups are born on ice from early November to late December, but the pupping period may extend from early October to early January. Leopard seals are expected to overlap with the Antarctic proposed action area and vessel transit.

iv. Northern elephant seal

Northern elephant seals (*Mirounga angustirostris)* are found in eastern and central North Pacific. Breeding takes place on offshore islands and at mainland localities from central Baja California to northern California. Northern elephant seals migrate twice a year, returning to breed from December to March and again to molt for several weeks (at different times depending on sex and age). Post-breeding and post-molt migrations take most seals north and west to oceanic areas of the North Pacific and Gulf of Alaska, twice a year. Pupping occurs from late December to March. The California breeding stock would overlap with the Pacific Northwest proposed action area and vessel transit.

v. Northern fur seal

Northern fur seals (*Callorhinus ursinus)* are a widely distributed pelagic species in the waters of the North Pacific Ocean, Bering Sea, Sea of Okhotsk, and Sea of Japan. They range from Northern Baja California, Mexico north and offshore across the North Pacific to northern Honshu, Japan. Their southern limit is ~35° N. The majority of Northern fur seal population breeds in Alaska on the Pribilof Islands, with a substantial number on the Commander Islands; a few still use San Miguel Island, California; Bogoslof Island, Bering Sea; and Robben Island, Russia. Breeding on the Pribilofs occurs from mid-June through August (California is usually two weeks earlier than the median date at the Pribilofs). During the non-breeding season (September through May), northern fur seals likely spend most of their time at sea, though a few may stay on islands year-round. The Eastern Pacific stock may overlap with the Pacific Northwest proposed action area and vessel transit.

vi. Ribbon seal

Ribbon seals (*Histriophoca fasciata*) occur in the Sea of Okhotsk, Sea of Japan, western North Pacific, and from the Bering Sea north through the Chukchi Sea, east to 160° W. However, they are rarely seen in the western Beaufort Sea. Ribbon seals inhabit the southern edge of the pack ice from winter to early summer; most are pelagic in the Bering Sea during the summer. Some may venture south of the Aleutian Islands in the summer when they are not typically associated with sea ice. They prefer sea ice from the continental slope seaward out over deeper oceanic areas, especially areas of pack ice coverage of 60–80 percent, and they do not like highly concentrated pack or areas of sheet ice coverage. Pups are born on ice floes from early April to early May. The Alaska stock of ribbon seal may overlap with the Arctic proposed action area, although the likelihood is low based on where icebreaking is expected to occur, and vessel transit.

vii. Sea otter

Information on non-ESA listed sea otters would be similar to the information found in Section 3.2.7.4.m on ESA-listed sea otters. The California Southern sea otter would overlap with the Pacific Northwest proposed action area and vessel transit. The Northern sea otter (Southcentral Alaska, Southeast Alaska, and Washington stocks) would overlap vessel transit only.

viii. Spotted seal

Spotted seals (*Phoca largha*) are widespread in the Sea of Okhotsk and the Sea of Japan, and reach China in the northern Yellow Sea. Spotted seals also inhabit the Bering and Chukchi Seas and range north into the Arctic Ocean, north to about the end of the continental shelf and west to about 170° E to

MacKenzie River Delta, Canada. They inhabit southern edges of the pack ice from winter to early summer and in late summer and fall move to coastal areas including river mouths. Spotted seals breed exclusively and haul out on sea ice, but do come ashore on beaches, sandbars, mudflats or rocky reefs. Breeding takes place on pack ice from January to mid-April; pups (peak numbers) are born mid-to late March. The Alaska stock of spotted seal would overlap with the Arctic proposed action area and vessel transit.

ix. Steller sea lion

More information on non-ESA listed Steller sea lions, the Eastern DPS, would be similar to the information found in Section 3.2.7.4.l on ESA-listed Steller sea lions, the Western DPS. They breed in late spring and summer and pups are born from May through July. There are no haulouts near the Pacific Northwest proposed action area, but the Eastern U.S. DPS could overlap with the Pacific Northwest proposed action area and vessel transit.

x. Walrus

Walruses have a circumpolar distribution in the Arctic Ocean and are associated with pack ice everywhere they are found, at least during winter. The walrus (*Odobenus rosmarus*) is not currently listed as threatened or endangered under the ESA (82 FR 46618; October 5, 2017). The Pacific walrus (*O. r. divergens*) within the U.S. EEZ is not designated as depleted under the MMPA (the Alaska stock), but is classified as strategic because the level of human-caused removal exceeds the potential biological removal.

Walruses are known to stay fairly close to land for most of their lives and make shallow dives inshore (depths of roughly 98 ft [80 m]) (Kastelein et al. 2002b) from the continental shelf and slope, so they do not regularly occur in deep oceanic waters. Walruses haul out on ice floes and sandy beaches or rocky shores, along remote stretches of mainland coastlines or islands (Jefferson et al. 2008; Kastelein 2009). Walruses haul out on land largely during years with reduced pack ice. The movements of walruses generally follow the movements of pack ice. However, some individuals do travel far from pack ice during summer. Pacific walruses range throughout the continental shelf waters of the Bering and Chukchi Seas, occasionally moving into the East Siberian Sea and the Beaufort Sea. The shallow, productive, ice-covered waters of the eastern Chukchi Sea are considered particularly important habitat for female walrus and their dependent young. A significant proportion of the Pacific walrus population migrates into the Chukchi Sea region each summer.

Several thousand animals (primarily adult males) aggregate near coastal haulouts in the Gulf of Anadyr and Kamchatka Peninsula (Russia), Bering Strait region, Bristol Bay, Sea of Okhotsk, and Honshu Island (Japan). During the late winter breeding season, most walruses are found in two major Bering Sea concentration areas where open leads, polynyas, or thin ice allows open water access (Fay et al. 1984). While the specific location of these groupings can vary annually and seasonally depending upon the extent of the sea ice, one group will generally range from the Gulf of Anadyr into a region southwest of St. Lawrence Island (northern Bering Sea), and the second group will aggregate in the southeastern Bering Sea from the south of Nunivak Island to northwestern portions of Bristol Bay. Based on the above information, walrus would not overlap with the Arctic proposed action area, but would during vessel transit (Appendix A).

xi. Weddell seal

Weddell seals (*Leptonychotes weddellii*) are circumpolar and widespread in the Southern Hemisphere. They occur on fast ice, right up to the Antarctic continent and also on offshore pack ice north to the seasonally shifting limits of the Antarctic Convergence. Weddell seals are also present on subantarctic islands along the Antarctic Peninsula that are seasonally ice free. Pups are born from September through November, but animals in the lower latitudes pup earlier than animals living at higher latitudes. Weddell seals would overlap with the Antarctic proposed action area and vessel transit.

3.2.7.6 Marine Mammal Hearing

Marine mammals use sound for communication, feeding, and navigation. Measurements of marine mammal sound production and hearing capabilities provide some basis for assessment of whether exposure to a particular sound source may affect a marine mammal behaviorally or physiologically. Hearing has been directly measured in some odontocete and pinniped species [in air and underwater] (see reviews in (Erbe et al. 2016; Finneran 2016; Southall et al. 2007)). To better reflect marine mammal hearing, Southall et al. (2007) recommended that marine mammals be divided into hearing groups and in 2016, NMFS made modifications as part of their technical guidance (Table 3-11) (NMFS 2016b).

Table 3-11. Marine Mammal Hearing Groups and Associated Generalized Hearing Range

Hearing Group	Generalized Hearing Range
LF cetaceans (baleen whales)	7 Hz to 35 kHz
MF cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	150 Hz to 160 kHz
HF cetaceans (true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger*, *L. australis*)	275 Hz to 160 kHz
PW underwater (true seals)	50 Hz to 86 kHz
OW underwater (sea lions and fur seals, polar bears)	60 Hz to 39 kHz

HF: high-frequency marine mammal hearing group; LF: low-frequency marine mammal hearing group MF: mid-frequency marine mammal hearing group; OW: otariid and non-phocid marine carnivore hearing group; PW: phocid marine mammal hearing group

3.2.7.6.a Mysticetes

Direct measurements of mysticete hearing are lacking. Thus, hearing predictions for mysticetes are based on other methods including: anatomical studies and modeling (Cranford and Krysl 2015; Houser et al. 2001b; Parks et al. 2007; Tubelli et al. 2012)); vocalizations (see reviews in (Au and Hastings 2008; Richardson et al. 1995; Wartzok and Ketten 1999)); taxonomy; and behavioral responses to sound ((Dahlheim and Ljungblad 1990); see review in (Reichmuth et al. 2007)). It is generally assumed that most animals hear well in the frequency ranges similar to those used for their vocalizations (songs or calls), which are mainly below 1 kHz in baleen whales (Richardson et al. 1995). Although auditory frequency range and vocalization frequencies do not always perfectly align, caution should be taken when considering vocalization frequencies along in predicting hearing capabilities of species for which no data exists, like mysticetes. Estimation of hearing ability based on inner ear morphology was completed for two baleen whale species: humpback whales (700 Hz to 10 kHz; (Houser et al. 2001a) and North Atlantic right whales (10 Hz to 22 kHz; (Parks et al. 2007)). Further, preliminary anatomical data indicate minke whales may be able to hear slightly above 22 kHz (Ketten and Mountain 2009). The anatomy of the baleen whale inner ear seems to be well adapted for detection of low-frequency sounds

(Ketten 1992a, 1992b, 1994). Thus, the auditory system of baleen whales is almost certainly more sensitive to low-frequency sounds than that of the small- or moderate-sized toothed whales. However, auditory sensitivity in at least some large whale species extends up to higher frequencies than the maximum frequency of the calls, and relative auditory sensitivity at different low-moderate frequencies is unknown.

3.2.7.6.b Odontocetes

Odontocetes use high-frequency biosonar signals to sense their environment. They have a broad hearing range extending to 200 kHz, but the frequency of best hearing range from 150 Hz to 160 kHz (Mooney et al. 2012; Tougaard et al. 2014). Auditory response curves for odontocetes show maximum auditory sensitivity near the frequencies where toothed whale signals have peak power (Mooney et al. 2012; Tougaard et al. 2014) at about 1,000 to 20,000 Hz for social sounds and 10,000 to 100,000 Hz or higher for echolocation. Like mysticetes, it is assumed that most animals hear well in the frequency ranges similar to those used for their vocalizations (songs or calls); although auditory frequency range and vocalization frequencies do not always perfectly align. Odontocetes use underwater communicative signals that, while not as low in frequency as those of many mysticetes, likely serve similar functions. These include tonal whistles, clicks, and pulsed calls in some odontocetes. Odontocetes generate short-duration (500–200 microseconds), specialized clicks used in biosonar with peak frequencies between 10 and 200 kHz to detect, localize, and characterize underwater objects such as prey (Au 1993; Wartzok and Ketten 1999). These clicks are often more intense than other communicative signals, with reported source levels as high as 229 dB re 1 µPa peak-to-peak (Au et al. 1974). The echolocation clicks of high-frequency cetaceans (e.g., porpoises) are narrower in bandwidth (i.e., the difference between the upper and lower frequencies in a sound) and higher in frequency than those of mid-frequency cetaceans.

3.2.7.6.c Pinnipeds and Carnivores

Unlike cetaceans who spend their entire lives in the water, pinnipeds and carnivores are adapted to live part of their lives in water and part on land and therefore would be expected to adapt to hearing in water and in air. Underwater hearing in otariid seals is adapted to low frequency sound and less auditory bandwidth than phocid seals. Hearing in otariid seals has been tested in California sea lion (Kastak and Schusterman 1998) and northern fur seal (Babushina et al. 1991; Moore and Schusterman 1987), whose ranges overlap with the proposed action areas. Kastelein et al. (2005) provided underwater audiograms of a male and female Steller sea lion, whose range also overlaps with the proposed action area. The audiogram of the male had a maximum hearing sensitivity at 77 dB at 1 kHz, with a best hearing range, between 1 and 16 kHz. The female Steller sea lion had a maximum sensitivity at 73 dB at 25 kHz. Kastelein et al. (2005) concluded that low frequency sounds are audible to Steller sea lions. Based on these studies, otariid seals would be expected to hear sounds within the ranges of 50 Hz to 75 kHz in air and 50 Hz to 50 kHz in water.

Phocid species have consistently demonstrated an extended frequency range of hearing compared to otariids, especially in the higher frequency range (Hemila et al. 2006; Kastelein 2009; Reichmuth et al. 2013). Phocid ears are anatomically distinct from otariid ears in that phocids have larger, more dense middle ear ossicles, inflated auditory bulla, and larger sections of the inner ear (i.e., tympanic membrane, oval window, and round window), which make them more adapted for underwater hearing (Hemila et al. 2006; Kastak and Schusterman 1998; Mulsow et al. 2011; Reichmuth et al. 2013; Schusterman and Moore 1978; Terhune and Ronald 1975).

Hearing in odobenids and polar bears are both very similar to that of otariids. The walrus is the only extant odobenid pinniped and may be found within the Arctic proposed action area. The walrus is adapted to low-frequency sound with a range of best hearing in water from 1 to 12 kHz and maximum hearing sensitivity around 12 kHz; its hearing ability falls off sharply at frequencies above 14 kHz (Kastelein et al. 2002b; Kastelein et al. 1996). The walrus hearing sensitivity is most similar to otariids, and therefore the walrus is assigned the same functional hearing range as for otariids for this analysis. Functional hearing limits are conservatively estimated to be 50 Hz–35 kHz in air and 50 Hz–50 kHz in water (Southall et al. 2007).

Traditional behavioral audiometry is difficult to perform for polar bears. Therefore, obtaining data on the hearing capabilities of polar bears presents a challenge. There have been a number of recent measurements of large mammal hearing using auditory evoked potential audiometry (Nachtigall et al. 2005; Supin et al. 2001; Yuen et al. 2005). Using this technique, the in-air range of best sensitivity for polar bears has been measured from 11.2 – 22.5 kHz by Nachtigall et al. (2007). Southall et al. (2007) determined that the polar bear has a range of best hearing from 50 Hz–50 kHz in water and 50 Hz–35 kHz in air.

Ghoul and Reichmuth (2014) studied a male sea otter and determined that the aerial audiogram of the sea otter resembled that of sea lions and showed a reduction in low-frequency sensitivity relative to terrestrial mustelids. Best sensitivity was 1 dB re 20 µPa at 8 kHz. Under water, hearing sensitivity was significantly reduced when compared to sea lions and other pinniped species, demonstrating that sea otter hearing is primarily adapted to receive airborne sounds. Critical ratios were more than 10 dB higher than those measured for pinnipeds, suggesting that sea otters are less efficient than other marine carnivores at extracting acoustic signals from background noise, especially at frequencies below 2 kHz.

3.3 Socioeconomic Environment

The following provides an overview of the predominant socioeconomic environments in the Arctic, Pacific Northwest, and Antarctic proposed action areas that are likely to be impacted (e.g., beneficial impact or negative impact, as discussed in Chapter 4) by the Proposed Action. Details on the commercial and recreational fishing, research, transportation and shipping, tourism, and subsistence hunting and cultural resources are below.

The Bering, Chukchi, and Beaufort Seas of the Arctic proposed action area cover a wide range of uses, including oil and gas exploration, fishing, mining, and tourism use. Statewide, based on data from 2013–2014, the main economic driver is the oil and gas industry while the second is the seafood (fishing and processing) industry (McDowell Group 2015). Combined, the key private sector industries, along with military and federal government activities provide an Alaskan economy that includes 465,000 jobs and $24 billion in annual income. In addition, these businesses and individuals contribute roughly $138.6 million to fund state, local, and federal government (McDowell Group 2015).

As stated in Section 2.1.1, there is no permanent human population on the Antarctic continent, save for researchers with the USAP. With no permanent population and virtually uninhabitable conditions, the economic activity on the continent is exceedingly limited. However, there are a few activities that take place in the region that do add some measure of economic value, as well as to the more than 30 nations that conduct them. Currently in Antarctica, scientific pursuits, rather than commercial undertakings, are the primary forms of most human activity. Fishing off the coast and tourism, industries that are both based abroad, comprise the limited economic activity on Antarctica, while researchers at a few scattered facilities make up Antarctica's small temporary population. The largest economic activity of value in Antarctica is commercial fishing.

The economic impact of the maritime industry in the Pacific Northwest, specifically Washington State, is roughly $30 billion (Community Attributes Inc. 2013). This includes maritime logistics and shipping, fishing and seafood processing, maritime support services, boat and ship building/repair/maintenance, and passenger water transportation. In 2012, the maritime industry in Washington directly employed 57,700 workers (Community Attributes Inc. 2013).

3.3.1 Commercial Fishing

3.3.1.1 Arctic Proposed Action Area Overview

Statewide, Alaska's commercial fishing industry constitutes 20 percent of the state's private sector economy in terms of income and full-time employment, with their 2014 harvest totaling 5.7 billion pounds (lb; 2.6 million metric tons) of seafood, more than all other state harvest volumes combined (McDowell Group 2015). Alaska's most robust fisheries include species of salmon, groundfish, and various shellfish. These fisheries are managed throughout state and federal waters. In general, federal management includes the EEZ regions of the Gulf of Alaska Management Area, the Bering Sea and Aleutian Islands Management Area, and the Arctic Management Area, which encompasses the Chukchi and Beaufort Seas. The Gulf of Alaska Management Area is located entirely outside of the Arctic proposed action area.

There is no commercial fishing allowed in the Arctic Management Area of the U.S. EEZ, including federal waters from Kotzebue Sound to the Chukchi Sea and extending into the Beaufort Sea (NPFMC 2009). The commercial fishing that takes place occurs in coastal waters managed by the state. In the Arctic Management Area there is subsistence fishing along the coast during summer and winter seasons for salmon and whitefish, along with additional species (NPFMC 2009). The Arctic Management Area is located within the Arctic proposed action area.

3.3.1.1.a Salmon

In 2015, the total annual commercial salmon landing was 1,040,771,655 lb (472,086 metric tons), the second-highest volume of Alaskan fish harvested that year, which included 604,704,575 lb of pink salmon; 289,645,447 lb (131,381 metric tons) of sockeye salmon; as well as chum salmon; coho salmon; and Chinook salmon (National Marine Fisheries Service 2017a). While salmon is Alaska's most highly valued fishery, bringing in a total of $2 billion in annual labor income to the economy in 2013, the fishery is largely prohibited in the EEZ (McDowell Group 2015). Salmon fishing is limited to coastal and inland waters where salmon runs occur between June and September. The northernmost commercial salmon fishery, opened in 1962, is harvested in Kotzebue Sound, with chum salmon being primarily harvested (Menard et al. 2017). Trawlers are the only boats authorized to harvest salmon in the East Area (east of Cape Suckling) of the EEZ (NPFMC 2012a). In state waters, gillnetters and purse seiners make up the bulk of the salmon commercial fishing industry (NPFMC 2012a).

3.3.1.1.b Groundfish

Walleye pollock is the largest single-species fishery found in Alaska by both volume and catch dollar value. According to NMFS, the 2015 annual commercial pollock catch was 3,262,567,947 lb (1,479,876 metric tons), composing over 50 percent of Alaska's total catch for that year (National Marine Fisheries

Service 2017a). After pollock, principal groundfish fisheries include Pacific cod, Pacific ocean perch (*Sebastes alutus*), sablefish (*Anoplopoma fimbria*), Atka mackerel, and various species of rockfish and flatfish. The initially targeted species was yellowfin sole (*Limanda aspera*), a flatfish, but after its decline in abundance in the 1960s, pollock has become the main groundfish fishery. The yellowfin sole fishery is still present in the eastern Bering Sea (NPFMC 2017).

3.3.1.1.c Shellfish

Alaska is known for its crab, and there are several important crab fisheries in the Alaskan region. In 2015, snow crab was the most commercially successful shellfish fishery, bringing in $133,698,748 in value for 80,794,108 lb (36,647 metric tons) in weight (National Marine Fisheries Service 2017a). Tanner crab (*Chionoecetes bairdi*) and species of king crab (*Paralithodes* spp.) are also commercially valuable. Tanner crab is fished both in the Bering Sea and in waters off the Aleutian Islands in the Gulf of Alaska, and snow crab is harvested in the Bering Sea (NPFMC 2011). Of the four species of king crab (red, blue, golden, and scarlet [*L. couesi*]), red king crab is the most prominent group, with the pot fisheries in Norton Sound and Bristol Bay increasing in abundance since the 1990s (Alaska Department of Fish and Game 2017i). The crab fishery seasons include a summer harvest, typically beginning in May, as well as a winter season that extends from November to May (NPFMC 2011), resulting in a year-round harvest. Commercial shellfish fisheries also include squid, shrimp, clams, sea cucumbers, octopus, and many other miscellaneous shellfish (National Marine Fisheries Service 2017a).

3.3.1.2 Antarctic Proposed Action Area Overview

Antarctica has minimal commercial fishing, including only four main fisheries: Antarctic krill, Mackerel icefish (*Champsocephalus gunnari*), Antarctic toothfish, and Patagonian toothfish (*Dissostichus eleginoides*). Out of the four species, Antarctic toothfish and Patagonian toothfish are the only fish caught in the Antarctic proposed action area (the Ross Sea, also referenced as statistical Subareas 88.1 and 88.2). These fisheries are exploratory in capacity, which limits fishery expansion. The 2016 annual catch of toothfish in Subarea 88.1 (the Ross Sea between 170° W and 150° E) was 5,917,207 lb (2,684 metric tons), with 5 of those metric tons being Patagonian toothfish (Commission for the Conservation of Antarctic Marine Living Resources 2016a). In Subarea 88.2 (Ross Sea between 105 ° W and 170° W) of the same year, the toothfish catch was 1,362,000 lb (618 metric tons) and consisted entirely of Antarctic toothfish (Commission for the Conservation of Antarctic Marine Living Resources 2016b).

3.3.1.1 Pacific Northwest Proposed Action Area Overview

In the state of Washington, commercial fisheries generate an average of $1.6 billion annually, after processing through wholesalers, and support 14,000 jobs (TCW Economics 2008). The commercial fishing industry is structured around multiple species including groundfish, halibut, albacore, salmon, and shellfish. In 2015, the statewide landings totaled 153,600,000 lb (69,672 metric tons) and generated $300 million in price-per-pound value (TCW Economics 2008). In 2006, groundfish (e.g., whiting, flatfish, rockfish, lingcod [*Ophiodon elongatus*], and sablefish) comprised 54 percent of these landings, but shellfish generated the greatest share of price-per-pound value at 63 percent. Within the groundfish category, Pacific whiting accounted for more than 85 percent of landings in 2006 (TCW Economics 2008). Ports along Washington's coast include La Push, Copalis Beach, Grays Harbor, Westport, Willapa Bay, and Ilwaco. Commercially, this coastal region was responsible for roughly 90,660 lb (41 metric tons) of landings valuing $41,158 in 2006 (TCW Economics 2008). Because the Pacific Northwest proposed action area is relatively small, these numbers are substantially higher than those that would be solely represented in the Pacific Northwest proposed action area.

3.3.2 Recreational Fishing

Below is a description of recreational fishing in the Arctic and Pacific Northwest proposed action areas. Due to the lack of substantive recreational fishing in Antarctica, that area is not discussed in this analysis.

3.3.2.1 Arctic Proposed Action Area Overview

Sport anglers commonly fish for Chinook salmon, coho salmon, pink salmon, sockeye salmon, chum salmon, Arctic grayling (*Thymallus arcticus*), rainbow trout, lake trout (*Salvelinus namaycush*), Arctic char (*S. alpinus*), Dolly Varden (*S. malma*), sheefish (*Stendous leucichthys*), Northern pike (*Esox lucius*), and burbot (*Lota lota*). Occasionally, anglers take least cisco (*Coregonus sardinella*), humpback whitefish (*C. pidschian*), round whitefish (*Prosopium cylindraceum*), and broad whitefish (*C. nasus*) (Alaska Department of Fish and Game 2017a). The North Slope sport fish population is slow growing due to cold water temperatures. Statewide, the Alaska Sport Fishing Survey reports that from 2006 through 2015, a total average of 643 lb (292 kilogram [kg]) of salmon was caught in the Arctic-Yukon-Kuskokwim region (Alaska Department of Fish and Game 2017a).

3.3.2.2 Pacific Northwest Proposed Action Area Overview

The state of Washington’s recreational fish species include Chinook, chum, coho, pink, sockeye, jackchin and jackcoho salmon; white sturgeon (*Acipenser transmontanus*); steelhead; and many species of marine fish and shellfish. In the 2015/2016 fishing season, the state of Washington sold over 1.5 million recreational licenses totaling over $27 million in sales (Kraig and Scalici 2017). In 2015, the state’s employment impacts were 6,500 jobs and overall sales impacts were $775 million due to the saltwater recreational fishing industry. The Pacific Region (California, Oregon and Washington) saw a decrease in the industry as a whole in 2015. The number of recreational trips decreased 9 percent from 2006 and 10 percent from 2014. 1.2 million anglers fished—a 32 percent decrease from 2006 and a 15 percent decrease from 2014 (National Marine Fisheries Service 2017b).

3.3.1 Research

Research is conducted in all proposed action areas and plays a significant role in the development and dissemination of knowledge in these areas. Despite the significant contribution of research in the Arctic and Pacific Northwest proposed action areas, research in Antarctica is highlighted below because scientific pursuits, rather than commercial undertakings, are the primary forms of most human activity in Antarctic proposed action area.

3.3.1.1 Antarctic Proposed Action Area Overview

As of 2012, approximately 30 countries maintained roughly 70 research stations in Antarctica, 40 of which operate year-round and 30 that are opened only during the austral summer. Staffing these centers are approximately 4,000 researchers; only 1,000 remain on the continent during the winter (National Science Foundation (NSF) United States Antarctic Program (USAP) 2017).

The largest of these stations is McMurdo Station, located on the bare volcanic rock of Hut Point Peninsula on Ross Island, within the Antarctic proposed action area. The station was established in December 1955 and is the logistics hub of the USAP, with a harbor, landing strips on sea ice and shelf ice, and a helicopter pad. McMurdo Station is made up of approximately 85 buildings including repair facilities, dormitories, administrative buildings, a firehouse, power plant, water distillation plant, wharf, stores, clubs, warehouses, and a first class lab which are all linked by above-ground water, sewer, telephone, and power lines. McMurdo Station is the port of entry for most USAP cargo and personnel on the continent, and serves as a logistics facility for airborne re-supply of inland stations and for field science projects. It is also the waste management center for much of the USAP (National Science Foundation (NSF) United States Antarctic Program (USAP) 2017). The average summer population of McMurdo Station is 1,100 people, while the winter population is 125 people (National Science Foundation (NSF) United States Antarctic Program (USAP) 2017). The USAP operates two vessels within the Antarctic: Research Vessel Nathaniel B. Palmer is a research ship with icebreaking capability that works throughout the southern ocean and Research Vessel Laurence M. Gould is an ice-strengthened research and resupply ship that works in the Antarctic Peninsula area and with Palmer Station in Antarctica (National Science Foundation (NSF) United States Antarctic Program (USAP) 2017), both located outside of the Antarctic proposed action area.

3.3.2 Transportation and Shipping

3.3.2.1 Arctic Proposed Action Area

Marine vessels transiting Arctic waters generally fall into one of five categories: (1) vessels that re-supply Arctic communities; (2) vessels that transport ore, oil, and gas in bulk; (3) fishing vessels; (4) passenger or tourism vessels; and (5) icebreakers, government vessels, or research vessels (Arctic Council 2009). Community resupply and coastal Arctic shipping involve a range of ship types, including tankers, general cargo and container ships, and in some areas, tug/barge combinations. Community resupply is expected to expand in the coming years due to both population increases in Arctic communities and increasing development in the region, stimulating demand (and thus, shipment) for goods and construction materials. In addition to the oil and gas fields off the coast of Alaska, a number of very large mines in the Arctic produce commodities such as nickel, zinc, and other ores. The Red Dog mine is both near to the coast and one of the world's largest zinc mines. Red Dog mine is located inland from Kivalina, in the Northwest Arctic Borough.

Ship activity involving bulk transport of ore, oil, and gas, is likely where the most growth will be witnessed in the near future (Arctic Council 2009). In Alaska, the area of greatest oil extraction is the North Slope Borough, while the coastal area of greatest mineral extraction is the Seward Peninsula near the Port of Nome. Nearly all passenger vessel activity in the Arctic takes place in ice-free waters in the summer season; the vast majority of it is for marine tourism.

Finally, icebreakers, government, and research vessels represent a relatively small proportion of the total vessel traffic in the Arctic but are invaluable for surveying, oceanographic research, vessel escort in ice, salvage, pollution response, and search and rescue. According to the tracking of all vessel traffic in 2004, the greatest amount of vessel traffic occurs in the proposed action area between the Alaskan Archipelago and the Bering Strait (Arctic Council 2009). Within the proposed action area, the western Alaskan coast is the area in which fishing vessels also spend the greatest number of days at sea. The number of vessels travelling north of the Bering Strait along the northern Alaskan coast diminishes quickly (Arctic Council 2009). As governments look to capitalize on new resources and sea routes in the melting Arctic Ocean, figures show that the number transits through the Bering Strait totaled 220 in

2008 and increased to 540 in 2015. Further south, in the Aleutian Islands, Unimak Pass recorded 3,491 transits in 2006, which increased to 4,615 in 2012 (Nuka Research and Planning Group and Pearson Consulting 2014).

Current Arctic marine shipping is mainly intra-Arctic. Trans-Arctic marine shipping can take place by means of various routes and combinations of routes. Two of these routes are the Northwest Passage and the Northern Sea Route. Since 2000, a small number of trans-Arctic voyages have occurred in summer for science and tourism purposes across the Northwest Passage and the Northern Sea Route (Molenaar and Corell 2009). All trans-Arctic marine shipping must pass through the Bering Strait, thus making it a ‘choke point’. The Northwest Passage is the shipping route most commonly used within the proposed action area. This passage is the name given to the various marine routes between the Atlantic and Pacific oceans along the northern coast of North America. In the western approaches, ships proceed through the Bering Sea, Bering Strait, the Chukchi Sea, and the Beaufort Sea before determining which route to follow through the Canadian Arctic. In general, the operating season is short—from late July to mid-October, depending on the route and year (Molenaar and Corell 2009). In the Bering Sea, some of the vessels are involved in shipping along the North Pacific Great Circle Route through the Aleutian Islands, but most of the ship traffic is bulk cargo ships serving the Red Dog mine, fishing vessels, and coastal community re-supply vessels (Arctic Council 2009).

3.3.2.2 Antarctic Proposed Action Area Overview

Transportation and shipping in the Antarctic proposed action area is generally limited to annual resupply missions to McMurdo Station. These have been undertaken by a combination of Coast Guard icebreakers, ice-strengthened Military Sealift Command vessels, and contracted Swedish and Russian vessels (Coast Guard News 2017; Mervis 2011; National Academies Press 2007).

3.3.2.3 Pacific Northwest Proposed Action Area Overview

Maritime logistics and shipping makes up roughly 25 percent of the total revenue brought in by Washington’s maritime industry (Community Attributes Inc. 2013). The Ports of Seattle and Tacoma form the third-largest gateway to North America, based on number of containers coming through the two seaports. Combined, a total of 36.1 million short tons (32.7 million metric tons) of cargo moved through the two ports in 2013. This cargo, as import/export cargo, was valued at $77 billion. Directly and indirectly, the two ports supported a total of 48,100 jobs in 2013 (Martin Associates 2014.). The gross business income for the maritime logistics and shipping industry was $3.7 billion (out of $15.2 billion) in 2012 (Community Attributes Inc. 2013). The passenger water transportation subcategory supported 4,300 jobs in 2012. This same year, the gross business income was $0.5 billion (out of a total $15.2 billion) (Cohen 2014).

Ocean shipping is a significant component of the regional economy. Washington State handles 7 percent of the country's exports and 6 percent of its imports. The maritime Port of Seattle was the nation’s 6th-busiest waterborne freight gateway for foreign trade by value of shipments in 2016 (American Association of Port Authorities 2016b). More than 2,000 vessels called at the Port of Seattle in 2014 (U.S. Department of Transportation 2017). Barges made the most calls at the port, accounting for 69 percent, while 21 percent of the calls were by container ships. Seattle and Tacoma were ranked 28th and 29th, respectively, among U.S. ports for total cargo imported and exported in 2015 (American Association of Port Authorities 2015). Taken together, these two ports make up the nation's fifth-largest container load center in the United States (American Association of Port Authorities 2016a). In total, Washington has 11 other key ports.

Ocean traffic is the transit of commercial, private, or military vessels at sea, including submarines. The ocean traffic flow in congested waters, especially near coastlines, is controlled by the use of directional shipping lanes for large vessels, including cargo, container ships, and tankers. Traffic flow controls are also implemented to ensure that harbors and ports of entry remain as uncongested as possible. There is less control on open-ocean traffic involving recreational boating, sport fishing, commercial fishing, and activity by naval vessels. In most cases, the factors that govern shipping or boating traffic include adequate depth of water, weather conditions (primarily affecting recreational vessels), availability of fish and other marine resources, and temperature.

Most vessels entering or leaving the Washington ports travel northwest, southwest, or south and may cross through the Pacific Northwest proposed action area. Shipping to and from the south typically follows the coastline of Washington, Oregon, and California. The Olympic Coast National Marine Sanctuary is located along the northwest coast of Washington and is listed as an Area to be Avoided by vessels. In general, ships traveling between Washington ports, Hawaii, and the Far East travel via the most direct, or great circle, route.

3.3.3 Tourism

3.3.3.1 Arctic Proposed Action Area Overview

Statewide, the tourism industry provides 37,800 jobs and $1.3 billion in labor income to the State of Alaska (McDowell Group 2015); however, there is limited ship-based tourism to Alaska within the proposed action area. While ferries and cruises visit many of the cities in the southeast, they rarely, if ever, reach areas of Alaska north of the Aleutians. In 2016, Nome hosted the Crystal Serenity cruise ship and its 1,700 passengers and crew (City of Nome Alaska 2016). Some smaller cruise ships sail regularly between Nome, Greenland, Russia, Norway, and other global destinations.

Most travel by tourists or business travelers is done by air. Many of the communities within the proposed action area are not accessible by roads from other parts of Alaska (NANA Regional Corporation 2016). The basic modes of transportation to and from Kivalina, for example are plane, small boat, and snow machine.

3.3.3.2 Antarctic Proposed Action Area Overview

Tourism has existed in Antarctica since 1957. Most of this has been small-scale “expedition tourism” and is currently subject to the provisions of the Antarctic Treaty and Environmental Protocol, but it is self-regulated by the International Association of Antarctic Tour Operators (IAATO). Not all vessels associated with Antarctic tourism are members of IAATO, but IAATO members account for about 95 percent of the tourist activity. Travel to Antarctica is largely accomplished by small or medium ships, with a focus on specific scenic locations with accessible concentrations of iconic wildlife. An estimated 70,000 tourists, most arriving by commercial ship, visit Antarctica each year—a number that has risen steadily since the beginning of the decade (International Association of Antarctica Tour Operators 2017). As estimated by IAATO, a total of 36,702 tourists visited the Antarctic Treaty area, as a whole, in the 2014–2015 austral summer, which is slightly lower than the 37,405 visitors in 2013–2014 (International Association of Antarctica Tour Operators 2017). From 2015–2016, there were 49 tourists that visited

McMurdo Station (International Association of Antarctica Tour Operators 2017), the only locale within the Antarctic proposed action area.

3.3.3.3 Pacific Northwest Proposed Action Area Overview

The Olympic Coast National Marine Sanctuary (OCNMS), east of the Pacific Northwest proposed action area, is a year-round draw for both national and residential visitors in Washington State. In 2014, approximately $102 million was generated from direct spending alone in the OCNMS (NOAA NMS 2014a). Three million people visit the nearby Olympic National Park each year in order to experience a wide range of recreational activities and the coast's natural beauty (National Park Service 2016). In the OCNMS and along the Outer Coast of Washington, beach-going, hiking, camping, sightseeing and wildlife watching from the shore are the most common activities pursued, but visitors also take part in surfing, boating, kayaking, and scuba diving, along with other water-based recreation (NOAA NMS 2014b). Wildlife watching and sightseeing by boat are common, but due to the occasional harsh conditions along the outer Olympic Coast, and thus in the OCNMS, such water activities are less common than in more sheltered areas within the nearby straits and coastal areas (Olympic Coast National Marine Sanctuary 2011).

The cruise ship industry is also rapidly expanding in the Pacific Northwest. Overall, passenger numbers have been increasing as the industry looks for more ports-of-call for passengers, either for the Alaskan market or ships visiting Vancouver, British Columbia or Seattle (BST Associates 2006). Ferries also travel between local cities around the Peninsula, such as the international ferry Motor Vessel *Coho* that runs from Port Angeles to Victoria, Canada, but it is rare for a ferry to operate outside of the straits in off the coast (Black Ball Ferry Line 2017); thus, these ferries all operate outside of the Pacific Northwest proposed action area. The significance of tourism in the state is substantial, with statewide travel and tourism generating over $14 billion in direct spending and over 145,000 tourism-related jobs in 2008 (Olympic Coast National Marine Sanctuary 2011).

Recreational boating is part of a larger $4 billion industry that includes 235,000 registered vessels. There were 67 boatyards in the state of Washington in 2014, a steady decrease from 1997 when there were 130 (Schrappen 2014).

3.3.4 Subsistence Hunting and Cultural Resources

Subsistence hunting and cultural resources in the Arctic and Pacific Northwest proposed action areas are described below (Table 3-12). Due to the lack of subsistence hunting or native human populations in Antarctica, the area is omitted from the discussion. Detailed information on marine mammal subsistence hunting is provided under the species descriptions in the sections above.

Table 3-12. Subsistence Hunting and Gathering Resources

Resource	Proposed Action Area	
	Arctic	Pacific Northwest
Marine Mammals		
Beluga whale	x	
Bowhead whale	x	
Gray whale		x
Bearded Seal	x	
Ringed Seal	x	
Spotted Seal	x	
Fur Seal		x
Walrus	x	
Polar Bears	x	
Sea otter		x
Terrestrial Mammals		
Caribou	x	
Bear	x	
Dall sheep	x	
Fox	x	
Hare	x	
Moose	x	
Muskrat	x	
Wolf	x	
Wolverine	x	
Birds		
Ptarmigans	x	
Waterfowl	x	
Eggs	x	
Fish		
Arctic cisco	x	
Arctic grayling	x	
Black rockfish		x
Dolly varden	x	
Groundfish		x
Halibut	x	x
Herring	x	

Resource	Proposed Action Area	
	Arctic	Pacific Northwest
Pacific whiting		x
Sablefish		x
Saffron cod	x	
Salmon	x	x
Sheefish	x	
Whitefish	x	
Marine Invertebrates		
Clams	x	
Shellfish (multiple species)		x
Urchin		x
Other Resources		
Cranberries	x	
Greens	x	
Berries	x	
Roots	x	

3.3.4.1 Arctic Proposed Action Area Overview

Alaskans generally place a high value on being able to hunt, fish, and to live off the land, if desired. The Alaska Constitution guarantees equal access to fish, wildlife, and waters for all State residents. Traditionally, Alaska Natives hunted, fished, and lived off the land of necessity. They view subsistence hunting and gathering as a core value of their traditional cultures. For them, most subsistence activities are group activities that further core values of community, kinship, cooperation, and reciprocity. In Alaska, State and Federal definitions of subsistence and who is permitted to participate in the subsistence harvest differ. The ADFG defines subsistence fishing as “the taking of, fishing for, or possession of fish, shellfish or other fisheries resources by a resident of the State for subsistence uses [customary and traditional uses of fish]” (Alaska Department of Fish and Game 2011). Current Federal regulations define subsistence use as “the customary and traditional use by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools of transportation; for making and selling handicraft articles out of inedible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade” (Federal Subsistence Management Program 2017). The State definition makes subsistence harvesting available to all Alaska residents, while Federal land managers restrict the harvest to those whose primary residence is rural, and may restrict a particular harvest area to a specified community or group of communities. The entire State is defined as rural except for designated non-rural areas (Federal Subsistence Management Program 2017). Priority for subsistence harvesting in land management is expressed in the Alaska National Interest Lands Conservation Act, passed by Congress in 1980. Similar State legislation was struck down as violating the State Constitution. The Alaska National Interest Lands Conservation Act now applies only to Federal lands.

Subsistence resources on Federal lands and waters are managed by the Federal Subsistence Board. For some resources in certain areas, the Federal Subsistence Board has determined that all rural Alaskans are qualified subsistence users. For other areas, the Federal Subsistence Board has made more restrictive “customary and traditional” determinations of eligibility. For example, only the communities of Copper Landing, Hope, and Ninilchik may harvest salmon with dipnets in the Kenai River drainage. Customary and traditional use means “a long-established, consistent pattern of use, incorporating beliefs and customs transmitted from generation to generation. This use plays an important role in the economy of the community” (Federal Subsistence Management Program 2017).

Some marine resources are subject to Federal regulation. Subsistence hunting of marine mammals is governed by the MMPA, and is restricted to Alaska Natives who reside on the coast of the North Pacific Ocean or the Arctic Ocean. Halibut may be harvested by residents of rural communities through the Federal subsistence halibut program (Alaska Department of Fish and Game 2011).

Native communities along the Bering, Chukchi, and Beaufort Seas subsist largely on fish, land mammals, and marine mammals. The top species that are fished or hunted as subsistence foods include marine mammals such as ringed seals, bearded seals, walruses, and bowhead whales; fish such as Dolly Varden, Arctic char, sheefish, cod, whitefish, salmon, herring, and halibut; and land mammals such as caribou, moose, and Dall sheep (Wolfe 2004). Species of waterfowl (and their eggs) are also caught for subsistence. Statewide, fish compose most of the subsistence food (about 53 percent by weight), followed by land mammals (22 percent), marine mammals (14.2 percent), and birds and eggs (2.9 percent). Wild plants make up 4.2 percent, and shellfish make up 3.2 percent of subsistence food. In total, subsistence harvest represents 0.9 percent of the fish and game harvested annually in the state of Alaska (while 98.5 percent is taken as part of commercial fishing) (Fall 2016). In the Arctic region of

Alaska, the food harvest averages out to roughly 405 lb (184 kg) per person, while in the western region of Alaska, the harvest is 370 lb (168 kg) per person. For comparison, the harvest in more urban areas, like Anchorage, averages out to 15 lb (6.8 kg) per person (Fall 2016).

Many of these species migrate, so the hunting or fishing season would depend on the species presence near the Native community. For example, in Kotzebue, typically seasonal hunting and fishing begins in spring, hunting marine mammals such as bowhead whales, bearded seals, ringed seals, and, rarely, walruses (Georgette and Loon 1993). Migrating waterfowl and their eggs, as well as sheefish, herring, whitefish, and Dolly Varden are also caught in the spring. Late spring and early summer are the season for beluga whales and muskrats (*Ondatra zibethicus*). The summer subsistence foods include beluga, bird eggs, greens, berries, salmon, and Dolly Varden. Subsistence hunting in the fall may include caribou (*Rangifer tarandus)*, moose (*Alces alces*), bear (*Ursus* spp.), and Dall sheep (*Ovis dalli*) (Georgette and Loon 1993). As Dall sheep live in the mountains, hunters must travel to participate in these hunts. Also in the fall, waterfowl are hunted, whitefish are caught, and roots and cranberries are gathered. Late fall, and the arrival of sea ice, brings bearded, ringed, and spotted seals to Kotzebue, along with saffron cod. Finally, in the winter, many terrestrial mammals are caught and trapped, including caribou, moose, hare (*Lepus* spp.), wolf (*Canis lupus*), wolverine (*Gulo gulo*), and fox. Ptarmigans (*Lagopus* spp.), ringed seals, and sheefish are also taken, if available (Georgette and Loon 1993). Therefore, near Kotzebue, a seasonally varied list of marine mammals and fish are caught year-round, while terrestrial animals are typically hunted in the fall and winter.

In Barrow/Utqiagvik, use of the offshore environment occurs year-round, but primarily during the open lead and open water season, which is April through October (Stephen R. Braund Associates 2012). The community begins the spring season, typically in April, by hunting bowhead whales (and seals as available) in open leads along the Chukchi Sea. The summer and fall months are spent by hunting marine mammals (bearded and ringed seals, and walruses) in the open ocean, concluding with the fall bowhead whale hunt in October. During the late fall and winter months, residents target ringed seals on the ice as well as polar bears closer to shore. Barrow/Utqiagvik offshore use areas extend nearly 90 miles offshore to the north and up to approximately 60 miles offshore from the Chukchi and Beaufort Sea coasts. The majority of reported use areas do not extend beyond 60 miles from shore, however (Stephen R. Braund Associates 2012).

During the summer and fall months, Native residents set nets for various species of fish at coastal locations and harvest clams. Anglers operate gillnets or seines in the main rivers and to a lesser extent in coastal marine waters to harvest salmon. Beach seines are used to catch schooling or spawning salmon and other species of fish. The major portion of fish taken during summer months is air dried or smoked for later consumption by residents or occasionally their dogs. Subsistence salmon fishing in the Kotzebue Sound District continues to be important, but fish abundance and fishing activities vary from community to community (Alaska Department of Fish and Game 2017b). Along the Noatak and Kobuk rivers where chum salmon runs are strong, household subsistence activities in middle and late summer revolve around catching, drying, and storing salmon. In southern Kotzebue Sound, fewer salmon are taken for subsistence because of low availability. Some fishermen base their fishing effort out of their village, whereas others move seasonally to fish camps where they stay for several days to several weeks. The predominant species in the district is chum salmon, although small numbers of other salmon species are present. Many subsistence fishers operate gillnets in the rivers and coastal marine waters of the Arctic Area to harvest marine and freshwater finfish. Small numbers of chum, pink, and Chinook salmon have been reported by subsistence fishers along the coast (Alaska Department of Fish and Game 2017c).

Arctic cisco (*Coregonus autumnalis*) and broad whitefish are most commonly used for subsistence purposes along with Dolly Varden and Arctic grayling.

3.3.4.2 Pacific Northwest Proposed Action Area Overview

Four federally-recognized Washington Tribes (i.e., Hoh Indian Tribe, Makah Indian Tribe of the Makah Indian Reservation, Quileute Indian Tribe of the Quileute Indian Reservation, and Quinault Indian Nation) are currently or historically associated with the Pacific Northwest proposed action area. These Tribes in Washington have off-reservation Treaty usual and accustomed fishing grounds.

The Hoh Indian Tribe is a band of the Quileute Indian Tribe, although it is recognized as a separate Tribal entity. The Hoh Indians fish in offshore areas from the coastline to beyond 12 nm between the Quilayute River and the Quinault River (Freedman et al. 2004). The Makah Indian Tribe of the Makah Indian Reservation on the northwestern tip of the Olympic Peninsula was established by the Treaty of Neah Bay in 1855 (Tiller 2015a). The Makah Indian Tribe, of Nooktan origin, practiced a subsistence lifestyle centered on fishing for sea otters, whale, seal, and smaller species such as shellfish, and on trading these products with other Tribes (Tiller 2015a). In 1998, approximately 70 percent of the Tribal population was engaged in employment in fishing for salmon, groundfish, and sea urchins. Usual and accustomed fishing grounds for the Makah include offshore areas from the coastline to beyond 12 nm north of Norwegian Memorial (Freedman et al. 2004). The Quileute Indian Tribe members are related to the Hoh Tribe. They historically practiced a hunting, fishing, and gathering subsistence lifestyle, dominated by the use of seal and whale oil, which also was used as a valuable trading commodity (Tiller 2015b). Many present-day Quileute derive their livelihood from the tourism, small commercial development, logging, and fishing industries. Usual and accustomed fishing grounds for the Quileute include offshore areas from the coastline to beyond 12 nm between Sand Point and the Queets River (Freedman et al. 2004) extended to 40 nm (*United States v. State of Washington 2015*). The Quinault Indian Nation originally practiced a subsistence lifestyle centered on fishing, hunting, and gathering. The Quinault economy is based on gaming, tourism, media and communications, small commercial development, logging, and fishing industries. Usual and accustomed fishing grounds include offshore areas from the coastline to beyond 12 nm between Destruction Island and Point Chehalis (Freedman et al. 2004). In 2015, the U.S. District Court for the Western District of Washington in Seattle, Washington determined that the western boundary of the Quinault Indian Nation's usual and accustomed in the Pacific Ocean is 30 nm from shore (*United States v. State of Washington 2015*).

Some species that move through the Pacific Northwest proposed action area are culturally significant to the tribes of coastal Washington. Procurement of traditional resources, such as marine invertebrates and fish, is regulated by geographical area (e.g., usual and accustomed fishing grounds), fishing methods, season, and species limits per day or per size. Tribal fisheries are place-oriented, limited to the adjudicated usual and accustomed fishing grounds. This results in immobile fisheries that cannot move to a new location if the resources or habitats are depleted. The Pacific Northwest proposed action area is completely outside of all Tribal usual and accustomed fishing areas, as they are located further inshore.

In the offshore areas along the coast, all four Tribes conducting commercial fishing utilize trolling gear. Since 1983, Tribal regulations allow fishing for all salmon species with the exception of coho in May and June and fishing for all salmon species for portions of the summer, depending on stock abundance of each species. The duration of the summer fishing for all species of salmon has varied from 12 to 92 days with most years running between 20 and 42 days.

In 1994, the U.S. government formally granted the Hoh Indian Tribe, Makah Indian Tribe, Quileute Indian Tribe, and the Quinault Indian Nation, treaty rights to fish for groundfish, and concluded that, in general terms, the quantification of those rights is 50 percent of the harvestable surplus of groundfish available in the Tribes' usual and accustomed fishing grounds (described at 60 CFR 660.324). These Tribes have formal allocations for sablefish, black rockfish, and Pacific whiting and participate in ceremonial and subsistence and commercial fisheries off the Washington State coast. All Tribes participating in groundfish fisheries use longline vessels in their fleet, but only the Makah Indian Tribe has trawlers. Groundfish fishing occurs primarily with hook and line and pots (U.S. Department of the Navy 2006). Only the Makah Indian Tribe has fished on the Tribal Pacific whiting allocation, which takes place from May through September (U.S. Department of the Navy 2006).

The Hoh Indian Tribe, Makah Indian Tribe, Quileute Indian Tribe, and the Quinault Indian Nation possess and exercise treaty fishing rights to Pacific halibut. Specific halibut allocations began in 1986 with the Tribes in 1989 harvesting their full allocation in the offshore areas. In 1993, judicial confirmation of treaty halibut rights occurred and treaty entitlement was established at 50 percent of the harvestable supply of halibut in the Tribes' combined usual and accustomed fishing grounds, listed above. Tribal allocations are divided into a commercial component and a year-round ceremonial and subsistence component (U.S. Department of the Navy 2006). Tribal ceremonial and subsistence is year-round, while commercial Tribal fisheries occur in very narrow time windows, of two days or less, beginning in the first part of March. There are three successive seasons set by agreement. Active fishing on a commercial basis continues into May. Dates are sometimes changed at the last minute because of weather, per conferencing and agreement.

CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

This chapter discusses potential environmental consequences of the Proposed Action (the Preferred Alternative, Alternative 1) to the physical, biological, and socioeconomic environments described in Chapter 3 including direct, indirect, short-term, and long-term impacts on relevant environmental resources. Components of the Proposed Action that may potentially impact or harm the environment include: acoustic stressors such as underwater acoustic transmissions, and vessel, icebreaking, helicopter, and gunnery noise; and physical stressors such as vessel and aircraft movements, in-water devices, icebreaking, and military expended materials (MEM). Socioeconomic benefits of the Proposed Action are discussed in Section 4.3. An analysis of the potential environmental consequences under Alternatives 2 and 3 are also presented.

The potential impact or harm of the Proposed Action on each resource and critical habitat is analyzed by stressor. This section evaluates the likelihood that a resource would be exposed to, or encounter a stressor and identifies the impact or harm associated with that exposure or encounter. Activities that are part of the Proposed Action and their associated stressors can be found in Table 4-1. The likelihood of an exposure or encounter is based on the stressor, location, and timing relative to the spatial and temporal distribution each biological resource or critical habitat. Under the No Action Alternative, the Coast Guard would fulfill its missions in the Arctic and Antarctic using existing assets, which are reaching the end of their service lives; therefore, baseline conditions of the existing environment would remain unchanged and would not significantly impact or result in significant harm to the physical, biological, or socioeconomic environments. The Coast Guard anticipates that there may be supplemental environmental assessments prepared in support of individual proposed actions as new information is provided and would be tiered to this PEIS. In addition, impact or harm from vessel homeporting, maintenance, and decommissioning would be analyzed in a supplemental document once more information about these plans becomes known.

As part of the Coast Guard's mission in the Arctic and Pacific Northwest proposed action areas, outreach with community leaders and governments, including coordination of training events, would be conducted to avoid interfering with subsistence harvests. The Coast Guard will address issues and concerns about the Proposed Action with Tribal and community leaders. Planning may entail regular communication with Tribal and community leaders that occurs throughout PIB training and operations. Through this regular communication, subsistence hunting for ESA-listed species, such as bowhead whales, bearded seals, gray whales, Steller sea lions, and ringed seals, would not be impacted by the Proposed Action and will not be discussed further in the document.

Table 4-1. Activity Names, Proposed Action Areas, Frequency, and Associated Stressors

Activity[1]	Proposed Action Area(s)	Frequency per year	Hours per activity	Acoustic Stressors	Physical Stressors
Icebreaking Full Power[2]	Arctic	5	Up to 16	Vessel noise, icebreaking noise	Vessel movement, icebreaking
	Antarctic	4	Up to 16		
Icebreaking Half Power[2]	Arctic	5	Up to 16		
Icebreaking Quarter Power[2]	Arctic	11	Up to 16		
	Antarctic	22	Up to 16		
Maneuverability – Propulsion Testing (Sea Trials)	Pacific Northwest	1	Up to 2[3]	Underwater acoustic transmissions, vessel noise	Vessel movement
Maneuverability – Propulsion Testing (Post Delivery Trials)	Pacific Northwest	1	Up to 2[3]		
Maneuverability – Ice Condition testing	Arctic	1 time every 10 years	Up to 6[3]	Vessel noise, icebreaking noise	Vessel movement, icebreaking
Maneuverability –(In Ice) Bollard Condition Testing	Arctic	1 time every 10 years	2		
Vessel Escort	Antarctic	2	4– 16	Vessel noise, icebreaking noise	Vessel movement, icebreaking
	Arctic	1	24		
	Antarctic/Arctic	1	48		
Vessel Tow	Antarctic	1	1–48		
Vessel Operations: Passenger Transfer	Arctic	5	Up to 12	Vessel noise	Vessel movement
	Antarctic	4	Up to 12		
Vessel Operations: Law Enforcement	Arctic (Bering Sea)	20	Up to 12		
Search and Rescue Training	Arctic	1	4–12	Underwater acoustic transmissions, vessel noise, aircraft noise	Vessel movement, aircraft movement
	Antarctic	1	4–12		
AUV Deployments	Arctic	2 times per patrol	Up to 24	Vessel noise	Vessel movement, in-water devices
Diver Training	Pacific Northwest	To maintain proficiency: 1	2	NA	NA

Activity[1]	Proposed Action Area(s)	Frequency per year	Hours per activity	Acoustic Stressors	Physical Stressors
	Antarctic	time/month (warm season) In ice: 2 times /deep freeze For science: 2 times/patrol			
	Arctic				
Fueling Underway	Arctic	1 time every 5 years	3	Vessel noise	Vessel movement
	Antarctic				
Gunnery Training	Pacific Northwest (Open Ocean or Navy Range)	2	1	Vessel noise, gunnery noise	Vessel movement, in-water devices, military expended materials
Marine Environmental Response Training	Pacific Northwest	2	3–5	Vessel noise	Vessel movement, in-water devices
	Arctic				
Aircraft Operations: Landing Qualifications[4]	Arctic	2	Flight operation duration: 4 hours. Qualification evolution: 1 day	Vessel noise, helicopter noise	Vessel movement, aircraft movement
	Antarctic	2			
Aircraft Operations: Ice Reconnaissance[4]	Arctic	2	2	Aircraft noise	Aircraft movement
	Antarctic	2	2		
Aircraft Operations: Vertical Replenishment and Mission Support[4]	Arctic	2	16	Vessel noise, aircraft noise	Vessel movement, aircraft movement
	Antarctic	1	16		
Aircraft Operations: Community Outreach, Passenger Transfer[4]	Arctic	4	2–4	Vessel noise, aircraft noise	Vessel movement, aircraft movement
	Antarctic	4	2–4		

[1]Patrols would encompass all activities listed in table.
[2]Icebreaking is dependent on ice cover. Days provided in this table are based on averages from past years. Actual icebreaking days may vary from estimates above.
[3]Maneuverability testing would be 2–6 hours (depending on activity) and may occur on two consecutive days.
[4]Helicopters would likely be the aircraft supporting these activities

4.1 Acoustic Stressors

The acoustic stressors from the Proposed Action include underwater acoustic transmissions, vessel noise, icebreaking noise, aircraft noise, and gunnery noise. In general, the Coast Guard would use a medium or heavy PIB that would operate navigational technologies, including radar and sonar while underway. Acoustic sources associated with the Proposed Action are provided in Table 4-2.

Table 4-2. Sound Source Characteristics of Acoustic Stressors Associated with the Proposed Action

Source type	Frequency range [kHz]	Source level (dB re 1 µPa @ 1 m)	Associated Action
Small vessel	1–7	175	Small boat training, routine patrols
Large vessel	0.02–0.30	190	All sea operations and training
Icebreaking	0.01–0.1	205	Icebreaking activities
Single-beam echosounder (Fishfinder, Depth Sounder)	3.5–1,000 (24–200)[a]	205[b]	All sea operations and training, research and development
Helicopter UAV	20 Hz – 5 kHz 60 – 150 Hz	in air: 136 dB re 20 µPa in air: 80 dB re 20 µPa	Air support
Gunnery	ranging from 0.15–2.5 (with a peak from 0.90–1.5)	in air: 139–154 dB re 20 µPa at 50 ft (15 m)	Gunnery Training

[a] Typical frequency range for most devices that are commercially available
[b] Maximum source level is 227 decibels root mean square @ 1 meter, but the maximum source level is not expected during operations
[c] based on Luz (1983) and Ylikoski (1995)

Sound generated by aircraft is analyzed for both in-air and in-water effects. Airborne and underwater sound levels are normally expressed in dB. The decibel value is given with reference to (“re”) the value and unit of the reference pressure. The standard reference pressures are 1 µPa for water and 20 µPa for air. It is important to note that because of the difference in reference units between air and water, the same absolute pressure would result in different decibel values for each medium. Because animals are not equally sensitive to sounds across their hearing range, weighting functions are used to emphasize ranges of best hearing and de-emphasize ranges of less or no sensitivity. In air, sound levels are frequently “A-weighted” and seen in units of dBA, to account for sensitivity of the human ear to barely audible sounds. Many in-air sound measurements are A-weighted because the sound levels are most frequently used to determine the potential noise effect to humans.

4.1.1 Potential Acoustic Impacts

In assessing the potential impacts or harm to species from the Proposed Action from acoustic sources, a variety of factors must be considered, including source characteristics, animal presence, animal hearing range, duration of exposure, and impact thresholds for those species that may be present. Potential acoustic impacts could include PTS, TTS, or a behavioral response.

4.1.1.1 Hearing Threshold

The most severe effect of exposure to high intensity sound is hearing loss. The distinction between PTS and TTS is based on whether there is complete recovery of a threshold shift following a sound exposure. If the threshold shift eventually returns to zero (the threshold returns to the pre-exposure value), the threshold shift is considered a TTS. The recovery to pre-exposure threshold from studies of marine mammals is usually minutes to hours, for the small amounts of TTS induced (Finneran et al. 2005; Nachtigall et al. 2004). The recovery time is related to the exposure duration, sound exposure level, and the magnitude of the threshold shift, with larger threshold shifts and longer exposure durations requiring longer recovery times (Finneran et al. 2005; Mooney et al. 2009). If the threshold shift does not return to zero but leaves some finite amount of threshold shift, then that remaining threshold shift is a PTS.

4.1.1.2 Behavioral Responses

The response of an animal to an anthropogenic sound 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). Other variables such as the animal's gender, age, the activity it is engaged in during a sound exposure, the distance from the sound source, and whether it is perceived as approaching or moving away can also affect the way an animal responds to a sound (Wartzok et al. 2003). For marine mammals, a review of responses to anthropogenic sound was first conducted by Richardson et al. (1995). More recent reviews (Nowacek et al. 2007; Southall et al. 2007) address studies conducted since 1995 and focus on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated.

Southall et al. (2007) synthesized data from many past behavioral studies and observations to determine the likelihood of behavioral reactions at specific sound levels. While in general the louder the sound source the more intense the behavioral response, it was clear that the proximity of a sound source and the animal's experience, motivation, and conditioning were also critical factors influencing the response (Southall et al. 2007). After examining all of the available data, the authors felt that the derivation of thresholds for behavioral response based solely on exposure level was not supported because context of the animal at the time of sound exposure was an important factor in estimating response.

The zone of masking is the area in which noise may interfere with the detection of other sounds, including communication calls, prey sounds, and other environmental sounds. The potential effect from auditory masking (a sound that interferes with the audibility of another sound) is missing biologically relevant sounds (vocalizations or sounds of prey or predators) that marine organisms may rely on, as well as eliciting behavioral reactions such as an alert, avoidance, or other behavioral reaction (NRC 2005; Williams et al. 2015).

4.1.2 Underwater Acoustic Transmissions

The source for any active acoustic transmission discussed in this section is the single beam echosounder. This analysis only evaluated impact or harm from the main lobe since that would represent the highest energy output. The discussion below will focus only on those species' whose hearing range overlaps with the frequency range of this source, since the other characteristics suggest that this sound source would be considered *de minimis* (see Section 2.1.5). The Coast Guard analyzed the data and conducted an analysis of the species distribution and likely responses to the acoustic stressors based on available scientific literature.

Under the Proposed Action, the frequency of the acoustic transmissions would be above the hearing capabilities of invertebrates, some fish, birds, and sea turtles, so impacts of acoustic transmissions for these species is not considered further in this PEIS. In general, other marine species that may overlap with the Proposed Action are not expected to exhibit any response to navigational technologies. However, in the unlikely event that a marine species is exposed, due to the characteristics of the navigational technologies (e.g., narrow, downward-directed beam focused directly beneath the icebreaker), any response is expected to be temporary and short-term. The frequency of acoustic transmissions could overlap with the hearing ranges of other fish, EFH, and marine mammals. A qualitative discussion is provided below, but no additional quantitative modeling was conducted for marine species that might encounter the single beam echosounder, as no “take” as defined under the ESA or MMPA (applicable only to marine mammals, see Section 4.1.2.3), is anticipated. Acoustic transmissions associated with the Proposed Action would not alter the physical or biological features essential to the conservation of any ESA-listed species; therefore, acoustic transmissions associated with the Proposed Action are not expected to result in the destruction or adverse modification of federally-designated critical habitat.

4.1.2.1 Fish

As discussed in Section 3.2.3.5, most fish species can hear sounds between 50 and 1,000 Hz. Fish without hearing specialization (generalists) are not expected to detect signals emitted by the single beam echosounder associated with the Proposed Action, as the operating frequency range of this devices is about 3.5–1,000 kHz, which is well outside the hearing range of these fish. The ESA-listed fish species expected to come in contact with underwater acoustic transmissions are generally regarded as hearing non-specialists (Hastings and Popper 2005). As stated previously, however, fish species that are hearing specialists, which include Clupeiformes and Gadiiformes fish like cod and shad, are able to detect sounds from 0.2 to 180 kHz (Mann and Popper 1997; Popper 2014) while herring are able to detect sounds from 100—5,000 Hz (Mann et al. 2005). In most cases, however, the highest sensitivity of these fish is still at lower frequencies. Potential impact or harm to hearing specialist fish that may detect the signals from underwater acoustic transmissions includes TTS, behavioral reactions, and auditory masking. The echosounder is outside of the hearing range for herring and all other fish.

The TTS effect has been demonstrated in several fish species, but mainly in response to low frequency sources, where investigators used exposure to either long-term increased background levels (Smith et al. 2004) or short-term, intense sounds (Popper et al. 2005). Coast Guard vessels using acoustic sources would be continually moving throughout the proposed action area in order to fulfill mission responsibilities. As a result, a long-term increase in background noise levels is not expected as a result of the Proposed Action. As vessels pass over fish and emit echosounder signals, this may be considered a short-term sound, but is much less intense than a high-energy source like an air-gun (McCauley et al. 2003) that may result in TTS/PTS. Therefore, no PTS or TTS is expected in fish as a result of the Proposed Action.

Effects of the single beam echosounder on the behavior of fish are also considered. Specifically, sound exposure that would alter fish behavior in a manner that would affect critical behaviors or result in impacts to the population (e.g., locating food or a potential mate). Behavioral responses to loud noises could include a startle response, such as a fish swimming away from the source, a fish “freezing” and staying in place, or scattering (Popper 2015). Studies documenting behavioral responses of fish to vessels show that Barents Sea capelin (*Mallotus villosus*) may exhibit avoidance responses to engine noise, sonar, depth finders, and fish finders (Jorgensen et al. 2004). Avoidance reactions are quite variable depending on the type of fish, its life history stage, behavior, time of day, and the sound propagation characteristics of the water (Schwartz 1985). If an individual fish with enhanced hearing capabilities (limited to Clupeids), comes in contact with high frequency acoustic transmissions and is able to perceive the transmissions, it would be expected to exhibit short-term behavioral reactions, when initially exposed to acoustic emissions. The Proposed Action may result in behavioral reactions by pelagic Clupeids in close proximity to the acoustic signals, with fish exhibiting a startle response and/or vacating the area of increased noise. Due to the low intensity of the sound, fish would likely return to the area and assume normal behavior soon after exposure. This response would not significantly alter breeding or foraging patterns and therefore would have no population level effects.

Auditory masking refers to the presence of a noise that interferes with a fish's ability to hear biologically relevant sounds. Fish use sounds to detect both predators and prey, and for schooling, mating, and navigating (Popper 2003). Masking of sounds associated with these behaviors could impact or harm fish by reducing their ability to perform these biological functions. Any noise (i.e., unwanted or irrelevant sound, often of an anthropogenic nature) detectable by a fish can prevent the fish from hearing biologically important sounds including those produced by prey or predators (Popper 2003). Masking can impede the flight response of fish from predators or may not allow fish to detect potential prey in the area. The frequency of the sound is an important consideration for fish because many marine fish are limited to detection of the particle motion component of low frequency sounds at relatively high sound intensities (Amoser and Ladich 2005). Medium frequency sound, such as that of the echosounder, has a limited potential for propagation, owing to greater attenuation. Therefore, detection of the signal is only expected locally or regionally (within "a few 10s of kilometers" from the receiver), as the sound source is expected to attenuate to ambient levels within at most, 19–25 mi (30–40 km) from the source (Hildebrand 2009). Thus, only fish located within 19–25 mi (30–40 km) of the sound source have the potential to experience an increase in ambient noise levels from the mid-frequency acoustic transmissions. For a slow-moving vessel and a stationary fish, this equates to a few hours of increased ambient noise as the vessel moves through the area. Additionally, most biological sounds within the ocean environment are in the low frequency band of noise. Thus, masking of biological sounds by the echosounder is not expected as a result of the Proposed Action.

Acoustic transmissions associated with the Proposed Action would not result in significant impacts or result in significant harm to fish. Pursuant to the ESA, there would be no effect to ESA-listed bocaccio, Chinook salmon, chum salmon, coho salmon, Pacific eulachon, sockeye salmon, steelhead trout, or yelloweye rockfish, as the effects of acoustic noise are generally thought to be outside of the hearing ranges of these species, and therefore the impact would be discountable or insignificant.

4.1.2.2 Essential Fish Habitat

Acoustic transmissions could impact or harm water column EFH due to the increase in ambient sound level during the transmissions. However, this potential reduction in the quality of the acoustic habitat would be localized to the area of the Proposed Action, due to the attenuation of mid-frequency sonar noise, and temporary in duration, due to the movement of the vessels throughout the proposed action areas. The quality of the water column environment as EFH would be restored to normal levels immediately following the departure of vessels. Secondary effects to federally managed fish species (e.g., Arctic cod, coho salmon) are considered in Section 4.1.2.1 above.

Since the water column would not be altered in any measurable or lasting manner from the acoustic transmission associated with the Proposed Action, impacts to EFH would be local and temporary. Therefore, the Proposed Action would not result in adverse effects to EFH under the Magnuson-Stevens Act. Acoustic transmissions associated with the Proposed Action would not result in significant impacts or result in significant harm to EFH.

4.1.2.3 Marine Mammals

In assessing the potential impact or harm to marine mammal species from the Proposed Action, a variety of factors must be considered, including source characteristics, animal presence and hearing range, duration of exposure, and thresholds for impact or harm to species that may be present. The potential impact or harm from acoustic transmissions to marine mammals could include PTS, TTS, or a behavioral response. The Coast Guard analyzed the data and conducted an analysis of the species distribution and likely responses to the acoustic transmissions based on available scientific literature.

In 2016, NMFS published technical guidance, updated in 2018, that identifies the received levels, or acoustic thresholds, at which individual marine mammals are predicted to experience changes in their hearing sensitivity (either temporary or permanent) for acute, incidental exposure to underwater anthropogenic sound sources (Table 4-3). The guidance included a protocol for estimating PTS onset acoustic thresholds for impulsive (e.g., airguns, impact pile drivers) and non-impulsive (e.g., tactical sonar, vibratory pile drivers) sound sources for the following marine mammal hearing groups: low- (LF), mid- (MF), and high- (HF) frequency cetaceans, and otariid and non-phocid marine carnivores (OW) and phocid (PW) pinnipeds. NMFS' acoustic guidelines only address effects of noise on marine mammal hearing and do not provide guidance on behavioral disturbance. Thus, the guidance does not represent the entirety of the comprehensive analysis included here, but serves as a tool to help evaluate the effect during the Proposed Action on marine mammals and to make findings required by the National Oceanic and Atmospheric Administration's various statutes, such as the MMPA. Table 4-3 provides the resultant TTS onset auditory acoustic thresholds for non-impulsive sounds[10] from NMFS' technical guidance (National Marine Fisheries Service 2016c, 2018). Impulsive sources are not listed since no impulsive sources would be produced by any of the underwater acoustic transmissions. In addition, Table 4-3 provides PTS onset auditory thresholds derived from TTS for non-impulsive sounds, utilizing NMFS' technical guidance (National Marine Fisheries Service 2016c, 2018).

[10] Definition of Non-impulsive: produce sounds that can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent) and typically do not have a high peak sound pressure with rapid rise/decay time that impulsive sounds do (American National Standards Institute (ANSI) 2001; National Institute for Occupational Safety and Health (NIOSH) 1998).

Table 4-3. Onset of PTS and TTS Thresholds for Marine Mammals for Underwater Non-Impulsive Sounds

Group	Species	Physiological Criteria (24 hours)	
		Weighted Onset TTS[1]	Onset PTS (received level)
LF Cetaceans	All mysticetes	179 dB SEL_{cum}[2]	199 dB SEL
MF Cetaceans	Most delphinids, beaked whales, medium and large toothed whales	178 dB SEL_{cum}	198 dB SEL
HF Cetaceans	Porpoises, River dolphins, *Cephalorynchus* spp., some *Lagenorhynchus* species *Kogia* spp.	153 dB SEL_{cum}	173 dB SEL
PW (in water)	Harbor, Bearded, Hooded, Common, Spotted, Ringed, Baikal, Caspian, Harp, Ribbon, Gray, Monk, Elephant, Ross, Crabeater, Leopard, and Weddell seals	181 dB SEL_{cum}	201 dB SEL
OW (in water)	Guadalupe fur seal, Northern fur seal, California sea lion, Steller sea lion	199 dB SEL_{cum}	219 dB SEL

SEL: Sound Exposure Level

[1] Determined from minimum value of exposure function and the weighting function at its peak

[2] The SEL_{cum} metric accounts for the accumulated exposure (i.e., SEL_{cum} cumulative exposure over the duration of the activity within a 24-hour period)

Reference: NMFS Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (National Marine Fisheries Service 2016c)

The source level associated with the echosounder (205 dB) is a maximum level that was taken directly next to the source. The Coast Guard would not operate the echosounder at the maximum level. In addition, the received sound levels are expected to be much lower and not expected to cause any injury to mysticetes (LF cetaceans), odontocetes (MF and HF cetaceans), pinnipeds (PW in-water), or otariids and polar bears (OW in water) that may be within the proposed action areas because any received levels would be below onset of TTS and PTS for each hearing group given the diminished level of sound (outside the cone of noise directly below the vessel) and the transient nature of the noise as the vessels and marine mammals move. Non-auditory physiological effects or injuries that can theoretically occur in marine mammals exposed to strong underwater noise are stress, neurological effects, bubble formation, resonance effects and other types of organ or tissue damage. These effects would be considered injurious, but the source levels (Table 4-2) associated with the Proposed Action would not be expected to cause any non-auditory physiological effects or injuries to mysticetes, odontocetes, pinnipeds, or carnivores that may be within the proposed action areas. In addition, SOPs and BMPs, which are detailed in Chapter 6, the Coast Guard would minimize the impact or harm of the Proposed Action by monitoring the presence of marine mammals and maintaining or increasing distance between a PIB and a marine mammal. SOPs and BMPs initiate adaptive mitigation responses to marine mammals including reducing vessel speed, posting additional dedicated lookouts to assist in monitoring location of the marine mammals, avoiding sudden changes in speed and direction, avoiding crossing the path of a marine mammal, and avoiding approach of marine mammals head-on or directly from behind.

The echosounder's system operates in a wide range of frequencies (between 50 and 200 kHz). Although there is a lack of audiometry data, based on anatomical studies and analysis of sounds that they produce, most baleen whales hear best at low frequencies, from 7 Hz to 35 kHz (National Marine Fisheries Service 2016c; Southall et al. 2007). Watkins (1986) stated that humpback whales often react to frequencies from 15 Hz to 28 kHz, but did not react to frequencies above 36 kHz. Fin and right whales also often react to frequencies from 15 Hz to 28 kHz, but did not react frequencies above 36 kHz (Watkins 1986). Therefore, mysticetes are unlikely to detect or react to any frequency used by echosounders. Similarly, sea lions and fur seals hear best between 60 Hz to 39 kHz (Kastak and Schusterman 1998; Moore and Schusterman 1987; Schusterman et al. 1972; Southall 2005), and are unlikely to detect any frequency used by Coast Guard echosounder.

Most phocids can hear frequencies between 50 Hz and 86 kHz (National Marine Fisheries Service 2016c; Southall et al. 2007) but can detect sounds up to 140 kHz although sensitivity is low (Cunningham and Reichmuth 2016). Thus, it is possible that a phocid could detect or react to an echosounder if it was swimming within or near the vertical beam, but only if it was operating at a frequency within their hearing range. The overlap between the echosounder's frequency and the phocid best hearing range is limited to 50 and 86 kHz, which would be at the echosounder's lower operational frequencies. Although phocids can hear frequencies between 50 Hz and 86 kHz, sensitivity to noise decreases at the low and high ends of this range (Perrin and Wursig 2009). Sills et al. (2015) determined that hearing abilities for ringed seals are actually better than what Terhune and Ronald (1975) previously reported (from 2–50 kHz) with best sensitivity at 49 dB re 1 µPa (12.8 kHz in water) and critical ratio measurements ranging from 14 dB at 0.1 kHz to 31 dB at 25.6 kHz. Since the lowest operational frequency for the echosounder only overlaps with the high end of the phocid's best hearing range, the sensitivity to the echosounder is expected to be poor because of the ear's decreased sensitivity to extreme low and high frequency noise. Data suggest that exposures of pinnipeds to sources between 90 and 140 dB re 1 µPa @ 1 m do not elicit strong behavioral responses (Southall et al. 2007). In contrast, data on grey (*Halichoerus grypus*) and harbor seals indicate avoidance response at received levels of 135–144 dB re 1 µPa @ 1 m (Götz and Janik 2010). Wartzok et al. (1992a; 1992b) investigated the under-ice movements and sensory cues associated with under-ice navigation of ringed seals by attaching acoustic transmitters (60–69 kHz at 159 dB re 1 µPa @ 1 m).

Although the frequencies used in the Wartzok et al. (1992a; 1992b) studies were at the upper limit of ringed seal hearing, the ringed seals exhibited normal behavior (e.g., finding breathing holes). Because it is unknown at what exact decibel level a phocid, such as the bearded or ringed seals may elicit a response, it is expected that bearded or ringed seals may elicit similar behavioral responses as the other phocid seals described above if exposed to source levels higher than 140 dB re 1 µPa @ 1 m. Pinnipeds are expected to exhibit no more than short-term and inconsequential responses to the echosounder given the device's characteristics (e.g., narrow downward-directed beam), which is focused directly beneath the vessel. However, any response to the echosounder, although unlikely, is expected to be short-term, any disturbance is expected to be temporary, and any individual that did respond is expected to return to its normal behavior.

The maximum potential effect is expected for odontocetes, since their frequencies of best hearing range from 150 Hz to 160 kHz, which could overlap with low- and medium-frequency echosounder signals (Table 4-2). Beluga whales have been found to have quite sensitive hearing, from 32–80 kHz with thresholds below 60 dB re 1 µPa and from 11.2–90 kHz with thresholds below 70 dB re 1 µPa (Mooney et al. 2008). Harbor porpoise have a range of best hearing from 16–140 kHz, with reduced sensitivity around 64 kHz and maximum sensitivity from 100–140 kHz (Kastelein et al. 2002a). The sperm whale is the only ESA-listed odontocete that may be present in open ocean areas of the proposed action area. However, the northern most boundary of the sperm whale's range is near the Pribilof Islands, which are at the southernmost extent of the Arctic proposed action area; therefore, the likelihood that ESA-listed sperm whales would be observed within the Arctic proposed action area is low.

Sperm whales could overlap with the Pacific Northwest action area. There is some evidence of disruptions of sperm whale clicking and behavior from exposure to pingers in Watkins and Schevill (1975), the Heard Island Feasibility Test (Bowles et al. 1994), and the Acoustic Thermometry of Ocean Climate at Pioneer Seamount off Half Moon Bay, California (Costa et al. 1998). Sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders (emitting about 1 pulse per second at 6–13 kHz); however, sperm whales did not show a prolonged reaction to continuous pulsing from echosounders (Watkins and Schevill 1975). Goold (1999) reported that six sperm whales were driven through a narrow channel using ship noise, echosounder, and fishfinder emissions from a flotilla of 10 vessels. Although echosounders are expected to be operational the entire time any vessel is underway, Coast Guard assets would have trained lookouts monitoring for marine mammals and would follow SOPs and BMPs (see Chapter 6) to minimize the impact or harm of the Proposed Action to marine mammals. Specifically, Coast Guard vessels would not create a flotilla, like the one described in Goold (1999) and would not drive animals into a narrow channel. However, in the unlikely event that a sperm whale is within the proposed action area and within a range to detect the echosounder, sperm whales are expected to exhibit no more than short-term and inconsequential responses to the echosounder given the device's characteristics (e.g., narrow, downward-directed beam), which is focused directly beneath the vessel.

Similarly, Southern Resident killer whales are also odontocetes and their hearing range may also overlap with the echosounder signals. However, there is an extremely low likelihood that Southern resident killer whales would overlap with the Pacific Northwest proposed action area because it is farther offshore than their known range. Based on their hearing range, it is possible that the noise from the echosounder may be detected by Southern Resident killer whales, if they are within the vicinity of the transiting vessel. However, in the unlikely event that a Southern Resident killer whale is within the transiting route and within a range to detect the echosounder, Southern Resident killer whales are expected to exhibit no more than short-term and inconsequential responses to the echosounder given the device's characteristics (e.g., narrow, downward-directed beam), which is focused directly beneath the vessel.

As stated in the Coast Guard SOPs and BMPs in Chapter 6, vessel crew would be trained in marine mammal identification and these trained observers would alert the Commanding Officer of the presence of marine mammals to initiate the appropriate adaptive mitigation responses such as: reducing vessel speed, posting additional dedicated lookouts to assist in monitoring marine mammal locations, avoiding sudden changes in speed and direction, attempting to parallel the course and speed of the moving animal so as to avoid crossing its path, and avoiding approaching marine mammals head-on or directly from behind. Coast Guard vessels would support the recovery of protected living marine resources through internal compliance with laws designed to preserve marine protected species, including planning passage around marine sanctuaries, such as federally-designated critical habitat. These actions would minimize the impact or harm of acoustic transmissions from vessels to marine mammals and federally-designated critical habitat.

As described above, the acoustic transmissions associated with the Proposed Action may result in minor to moderate avoidance responses of odontocetes, over short and intermittent periods of time. The Proposed Action is not expected to cause significant disruptions such as mass haul outs, or abandonment of breeding, that would result in significantly altered or abandoned behavior patterns.

The effects of acoustic transmission noise are generally thought to be outside of the hearing ranges of the ESA-listed blue whale, bowhead whale, fin whale, gray whale, humpback whale, North Pacific right whale, sei whale and Steller sea lion; therefore, pursuant to the ESA, acoustic transmissions associated with the Proposed Action would have no effect on those species. Southern Resident killer whales may be able to detect the echosounder, although it is extremely unlikely that the vessel would overlap with Southern Resident killer whales. Therefore, in accordance with the ESA, the acoustic transmissions in the Proposed Action may affect, but are not likely to adversely affect ESA-listed marine mammals, including the Southern Resident killer whale, sperm whale, bearded seal, and ringed seal. Underwater acoustic transmissions would not alter any resources essential to the conservation of ESA-listed marine mammals. The Proposed Action is not expected to result in the destruction or adverse modification of federally-designated critical habitat of the North Pacific Right whale, Steller sea lion, Southern Resident killer whale, or the proposed critical habitat of the ringed seal. Acoustic transmissions from the Proposed Action are not likely to significantly impact or result in significant harm to marine mammals.

4.1.2.4 Impacts from Underwater Acoustic Transmissions Under Alternatives 2 and 3

Alternative 2: Leasing

Echosounders are used for navigational purposes, thus, it is assumed that any navigational equipment used on a leased vessel would be similar to what is in current use and the potential impact would be similar to what was analyzed under Alternative 1. Therefore, the potential impacts associated with underwater acoustic transmissions under Alternative 2 are the same as under Alternative 1. Therefore, acoustic transmissions from Alternative 2 are not likely to significantly impact or result in significant harm to fish, EFH, and marine mammals.

Alternative 3: No Action

Under the No Action Alternative, the Coast Guard would fulfill its missions in the Arctic and Antarctic using existing polar icebreaker assets, which are reaching the end of their service lives. The current polar icebreaker fleet uses echosounders for navigation while underway. Therefore, as long as the current polar icebreaker fleet is operational, baseline conditions of the existing environment would remain unchanged and would not significantly impact or result in significant harm to fish, EFH, and marine mammals. Once the current fleet of icebreakers are decommissioned and no longer in operation, the Coast Guard would no longer have polar icebreakers in their fleet and therefore, operations and training from a polar icebreaker would no longer occur.

4.1.3 Vessel Noise

Marine species within the proposed action areas may be exposed to vessel noise associated with Coast Guard assets during the Proposed Action. It is difficult to differentiate between behavioral responses to vessel sound and visual cues associated with the presence of a vessel (Hazel et al. 2007); thus, it is assumed both could play a role in prompting reactions from animals. The potential impact or harm from vessel noise is from masking of other biologically relevant sounds as well as behavioral reactions, such as an alerting or avoidance response. The noise made by Coast Guard vessels while icebreaking is discussed separately in Section 4.1.3.

Underwater sound from vessels is generally at relatively low frequencies, usually between 5 and 500 Hz (Hildebrand 2009; NRC 2003; Urick 1983; Wenz 1962). However, high levels of vessel traffic are known to elevate background levels of noise in the marine environment (Andrew et al. 2011; Chapman and Price 2011; Frisk 2012; Miksis-Olds et al. 2013; Redfern et al. 2017; Southall 2005). Anthropogenic sources of sound in the proposed action areas include smaller vessels such as skiffs, larger vessels for pulling barges to deliver supplies to communities or industry work sites, icebreakers, and vessels for tourism and scientific research which all produce varying noise levels and frequency ranges. Commercial ships radiate noise underwater with peak spectral power at 20–200 Hz (Ross 1976). The dominant noise source is usually propeller cavitation which has peak power near 50–150 Hz (at blade rates and their harmonics), but also radiates broadband power at higher frequencies, at least up to 100,000 Hz (Arveson and Vendittis 2000; Gray and Greeley 1980; Ross 1976). While propeller singing is caused by blades resonating at vortex shedding frequencies and emits strong tones between 100 and 1,000 Hz, propulsion noise is caused by shafts, gears, engines, and other machinery and has peak power below 50 Hz (Richardson et al. 1995). Overall, larger vessels generate more noise at low frequencies (<1,000 Hz) because of their relatively high power, deep draft, and slower-turning (<250 rotations per minute) engines and propellers (Richardson et al. 1995).

Low frequency ship noise sources include propeller noise (cavitation, cavitation modulation at blade passage frequency and harmonics, unsteady propeller blade passage forces), propulsion machinery such as diesel engines, gears, and major auxiliaries such as diesel generators (Ross 1976). Globally, commercial shipping is not uniformly distributed (NRC 2003). Other vessels may be found widely distributed outside of ports and shipping lanes. These include military vessels participating in training exercises, fishing vessels, and recreational vessels. The vessels participating in the Proposed Action may be in the proposed action areas at any given time for any given amount of time and would overlap spatially and temporally with the other vessels described above.

Vessel operations could create a zone of masking in the water for marine species. The potential impact or harm from vessel noise from auditory masking is missing biologically relevant sounds that marine organisms may rely on, as well as eliciting behavioral reactions such as an alert, avoidance, or other behavioral reaction (NRC 2003, 2005; Williams et al. 2015). The impact or harm of masking can vary depending on the ambient noise level within the environment, the received level, frequency of the vessel noise, and the received level and frequency of the sound of biological interest (Clark et al. 2009; Foote et al. 2004; Parks et al. 2011; Southall et al. 2000). In the open ocean, ambient noise levels are between about 60 and 80 dB re 1 µPa, especially at lower frequencies (below 100 Hz) (NRC 2003). When the noise level is above the sound of interest, and in a similar frequency band, auditory masking could occur (Clark et al. 2009). Any sound that is above ambient noise levels and within an animal's hearing range needs to be considered in the analysis; however, the degree of masking increases with the increasing noise levels. A noise that is just detectable over ambient levels is unlikely to actually cause any substantial masking above that which is already caused by ambient noise levels (NRC 2003, 2005).

Vessel presence, particularly for activities such as shipping, is diffuse and spread throughout the world's oceans (Hildebrand 2009). Vessel noise associated with the Proposed Action would not contribute meaningfully to these ambient sound levels areas of higher vessel traffic, including in the Pacific Northwest proposed action area or transit areas. In the more remote regions of the Arctic, such as in the Arctic proposed action area, the additional vessel noise would still be minimal compared to the noise of the ambient environment. As observed by Ozanich et al. (2017), the median noise levels in the Eastern Arctic near the North Pole varied according to the dominant sources, including noise generated from ice, bowhead whale calls as far north as 86°24' N, seismic surveys farther southward, and earthquakes in the Arctic Basin. Dziak et al. (2015) recorded tens of "icequakes" per day in Antarctica with underwater sound levels ranging between 190–247 dB_{RMS} re 1µPa @ 1 m. Veirs et al. (2016) measured ship noise in Puget Sound, Washington, and determined that median received spectrum levels of noise from 2,809 isolated transits are elevated relative to median background levels not only at low frequencies (20-30 dB re 1 mPa^2/Hz from 100 to 1,000 Hz), but also at high frequencies (5–13 dB from 10 to 96 kHz).

Vessel noise associated with the Proposed Action would not result in significant impacts or result in harm to invertebrates, seabirds, fish, sea turtles, and marine mammals. Vessel noise associated with the Proposed Action would not alter the physical or biological features essential to the conservation of any ESA-listed species; therefore, vessel noise associated with the Proposed Action is not expected to result in the destruction or adverse modification of federally-designated critical habitat. Pursuant to the ESA, vessel noise associated with the Proposed Action may affect, but is not likely to adversely affect ESA-listed fish: bocaccio, Chinook salmon, chum salmon, coho salmon, Pacific eulachon, sockeye salmon, steelhead trout, or yelloweye rockfish; ESA-listed birds: the marbled murrelet, short-tailed albatross, Steller's eider, and spectacled eider; ESA-listed sea turtles: leatherback turtles; ESA-listed marine mammals: bearded seal, blue whale, bowhead whale, fin whale, gray whale, humpback whale, North Pacific right whale, polar bear, ringed seal, sei whale, Southern Resident killer whale, sperm whale, and Steller sea lion. The potential effects of vessel noise are discussed in detail below.

4.1.3.1 Invertebrates

As discussed in Section 3.2.2.4, hearing capabilities of invertebrates are not widely studied, although they are not expected to hear sources above 3 kHz (Lovell et al. 2005; Popper 2008). Impacts to invertebrates from vessel noise are not well understood, but it is likely that many species would be able to perceive the low frequency sources generated from the vessels (Table 4-2) used during the Proposed Action, which could result in masking acoustic communication in invertebrates such as crustaceans (Staaterman et al. 2011). Masking of important acoustic cues used by invertebrates during larval orientation and settlement may lead to localized reductions in recruitment success (Simpson et al. 2011). Recent research suggests that some invertebrates may experience sub-lethal physiological impacts from prolonged exposure to high amplitude, low frequency sound (Celi et al. 2014; Wale et al. 2013). However, much of the Proposed Action would occur over deeper water, which would limit the exposure of benthic invertebrates, and since vessels are generally transiting through and are not expected to produce high amplitude low frequency sound, prolonged exposure to the type of high amplitudes used in the above referenced studies is unlikely.

Vessel presence, particularly for during shipping operations, is diffuse and spread throughout the world's oceans, and raises the ambient levels of sound (Hildebrand 2009). It is expected that vessel noise associated with the Proposed Action would be similar to vessel noise from other ships in the area, would contribute to ambient sound levels in the proposed action areas, but would not be expected to alter current levels of ambient sound. Vessel noise associated with the Proposed Action would be short-term and temporary as the vessel moves through an area; this short-term noise may affect invertebrates within the proposed action areas via masking. Vessel noise is not expected to result in more than a temporary behavioral reaction of marine invertebrates near the vessel noise. It is expected that invertebrates would return to their normal behavior shortly after exposure. Vessel noise, if perceived by an invertebrate, would likely result in temporary behavioral reactions, but would not result in any population level impact or harm.

Vessel noise associated with the Proposed Action would not result in significant impacts or result in significant harm to invertebrates. There are no ESA-listed invertebrates within the proposed action areas.

4.1.3.2 Fish

Vessel noise has the potential to expose fish to both sound and disturbance from particle motion, which could result in short-term behavioral or physiological responses (e.g., avoidance, stress, increased respiration rate). Vessel noise from the Proposed Action is not expected to impact or harm fish, as available evidence does not suggest that ship noise can injure or kill a fish (Popper 2014). Misund (1997) found that fish ahead of a ship showed avoidance reactions at ranges of 161 to 489 ft (49 to 149 m). When the vessel passed over them, some species of fish exhibited sudden escape responses that included lateral avoidance or downward compression of the school; though it is unclear if this avoidance behavior was due to the physical presence of the vessel, particle motion, or actual detection of the sound. Avoidance behavior of vessels, vertically or horizontally in the water column, has been reported for cod and herring, and was attributed to vessel noise (Handegard et al. 2003; Vabø et al. 2002). Vessel activity can also alter schooling behavior and swimming speed of fish (UNEP 2012).

It is anticipated that temporary behavioral reactions (e.g., temporary cessation of feeding or avoidance response) would not impact the individual fitness of a fish, as individuals are expected to resume feeding upon cessation of the sound exposure and unconsumed prey would still be available in the environment. Furthermore, while vessel sounds may influence the behavior of some fish species (e.g., startle response, masking), other fish species can be equally unresponsive (Becker et al. 2013).

Vessel presence, particularly for during shipping operations, is diffuse and spread throughout the world's oceans, and raises the ambient levels of sound (Hildebrand 2009). It is expected that vessel noise associated with the Proposed Action would be similar to vessel noise from other ships in the area, would contribute to ambient sound levels in the proposed action areas, but would not be expected to alter current levels of ambient sound. Vessel noise associated with the Proposed Action may affect individual fish within the proposed action areas; however, responses to vessel noise would be short-term and insignificant behavioral reactions, and thus, would not be expected to have any population level impacts.

Vessel noise associated with the Proposed Action would not result in significant impacts or result in significant harm to fish. Pursuant to the ESA, vessel noise associated with the Proposed Action may affect, but is not likely to adversely affect ESA-listed bocaccio, Chinook salmon, chum salmon, coho salmon, Pacific eulachon, sockeye salmon, steelhead trout, or yelloweye rockfish. The Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat for ESA-listed fish as it is located outside of the proposed action areas.

4.1.3.3 Seabirds and Shorebirds

Diving and non-diving birds could be exposed to in-air noise generated by the vessels. Seabird presence would vary depending on vessel location. Most information on in-air vessel noise focuses on noise produced by moored ships as they load and unload (Badino et al. 2012; Borelli et al. 2015) or the effects of noise on the ship's crew and passengers while underway (United States Coast Guard 1982). Ambient, environmental noise from the vessels while underway would consist of localized engine sounds, grinding and humming noises from the operation of winches and other machinery, and use of the ship's horn. As noted in Section 3.2.5.7, underwater hearing in diving birds is poorly studied, but they have been reported to hear best in air between 1 and 3 kHz (Crowell et al. 2015), and the only study of hearing in a penguin indicated best sensitivity between 0.6 and 4 kHz in air (Wever et al. 1969). Vessel noise is typically characterized as low frequency, or less than 1 kHz, which is below the range of best hearing in air for seabirds. Effects on seabirds would be limited to short-term startle responses and temporary displacement from the location in which vessels are operating.

While Godin (2006) states that the air-water interface is nearly transparent when it comes to the transmission of low-frequency sound, this low frequency sound is not within the range of best hearing for birds underwater, based on the general data that exists for seabird hearing underwater. The extent of these noises, and the transmission of these noises across the air-water interface, would vary with wind speed, temperature stratification, and nearby terrain, if any. Seabirds spend a limited amount of time underwater when compared to other marine species, and due to a lack of research in this area, it is unknown whether hearing plays a significant role in their life history. Woehler (2004) noted that the ability of penguins to vocalize underwater is indeterminate, perhaps providing more insight on the lack of a role that hearing might play in their life history. Due to variable species communication styles, behaviors, and hearing capabilities, researchers are unable to estimate the potential masking effects from vessel noise (Dooling and Popper 2007). Vessel noise is primarily low frequency (less than 1 kHz), and the range of best underwater hearing in seabirds is from 1–4 kHz, thus effects to seabirds from vessel noise would be expected to be minor. In the unlikely event that a seabird overlaps with the proposed activities, exposure to underwater vessel noise is expected to be temporary since seabirds spend a limited amount of time underwater and the transitory nature of a PIB's movement. While vessel noise could possibly elicit short-term behavioral responses, it is not likely to disrupt major patterns such as migrating, breeding, feeding, or sheltering. Vessel noise may also cause startle responses and a temporary displacement of seabirds from an area. However, any behavioral response to vessel noise is expected to be temporary and seabirds are expected to return to the area once the source of disruption, has moved away from the area.

Vessel presence, particularly for during shipping operations, is diffuse and spread throughout the world's oceans, and raises the ambient levels of sound (Hildebrand 2009). It is expected that vessel noise associated with the Proposed Action would be similar to vessel noise from other ships in the area, would contribute to ambient sound levels in the proposed action areas, but would not be expected to alter current levels of ambient sound. Vessel noise associated with the Proposed Action may affect individual seabirds within the proposed action areas; however, responses to vessel noise would be short-term and insignificant behavioral reactions, and thus, would not be expected to have any population level impacts.

Vessel noise associated with the Proposed Action would not alter the physical or biological features essential to the conservation of ESA-listed seabird species. Any increase in ambient noise as a result of a PIB would be temporary and localized to the position of the vessel as it moves throughout the proposed action areas. Seabirds are either not likely to respond to vessel noise or are not likely to respond in ways that would significantly disrupt normal behavior patterns which include, but are not limited to: migration, breeding, feeding, or sheltering. Coast Guard would follow SOPs and BMPs (see Chapter 6) and would maintain properly trained lookouts and would not purposefully approach large flocks of seabirds. Because vessel noise is low frequency and located at the edge of the hearing range of most seabirds, the effects of vessel noise are expected to be limited to behavioral effects and temporary and seabirds are expected to return to normal behavior within minutes of a disruption.

Vessel noise associated with the Proposed Action would not result in significant impacts to birds or result in significant harm to birds. Pursuant to the ESA, vessel noise associated with the Proposed Action may affect, but is not likely to adversely affect the ESA-listed marbled murrelet, short-tailed albatross, Steller's eider, and spectacled eider, nor would it result in the destruction or adverse modification of federally-designated critical habitat of the spectacled or Steller's eider. There would be no effect to federally-designated marbled murrelet critical habitat as it is located outside of the Pacific Northwest proposed action area. Pursuant to the MBTA, vessel noise associated with the Proposed Action would not result in a significant adverse effect on migratory bird populations.

4.1.3.4 Sea Turtles

As noted in Section 3.2.6.4, little is known about how sea turtles use sound in their environment. They may use sound for navigation, locating prey, avoiding predators, and general environmental awareness. However, sea turtles do not appear to use sound for communication. When presented with acoustic stimuli at 430 Hz and 1.5 dB re 1 μPa, sea turtles placed in 50-gallon (0.19 m^3) tanks responded with abrupt body movements, such as blinking, head retraction, and flipper movement, all of which were interpreted as startle responses (Lenhardt et al. 1996). More severe responses, such as changes in swimming patterns and orientation, were observed when sea turtles that were in a confined canal (984 ft [300 m] long, 148 ft [45 m] wide, and up to 33 ft [10 m] deep), suspended at 6-ft (2 m) depth, positioned 108 ft (33 m) inward from one side of the tank, and exposed to high-pressure air gun pulses (120 dB re 1 mbar @ 1 m) with frequencies ranging from 25 to 750 Hz (O'Hara and Wilcox 1990). Thus, vessel noise in the open ocean may cause a startle response in sea turtles. However, any response is expected to be short term and temporary. Overlap between the Arctic proposed action area and the range of the leatherback sea turtle is minimal (e.g., only as far north as the Aleutian Island chain). Vessel traffic often concentrates offshore in the Pacific Northwest proposed action area, thus vessel noise from the Proposed Action would not be expected to alter current levels of ambient noise. Masking impacts would be similar to what is currently present in the Pacific Northwest proposed action area because the proposed action activities are not expected to change the current ambient noise levels. Therefore, vessel noise from a PIB would not be expected to impact a sea turtle's ability to perceive other biologically relevant sounds. Sea turtles do not inhabit the Antarctic proposed action area.

Vessel noise associated with the Proposed Action would not result in significant impacts to sea turtles or result in significant harm to sea turtles. Pursuant to the ESA, vessel noise associated with the Proposed Action may affect, but is not likely to adversely affect ESA-listed leatherback turtles. The Proposed Action would not cause direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of the leatherback sea turtle because the proposed action area is outside of designated leatherback sea turtle critical habitat. Therefore, the Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat for the leatherback sea turtle.

4.1.3.5 Marine Mammals

Since many marine mammals rely on sound to find prey, moderate social interactions, and facilitate mating (Tyack 2008), noise from anthropogenic sound sources like ships can interfere with these functions, but only if the noise spectrum overlaps with the hearing sensitivity of the marine mammal (Clark et al. 2009; Hatch et al. 2012; Southall et al. 2007). It is difficult to differentiate between behavioral responses to just a vessel sound or just the visual cues associated with the presence of a vessel; thus, it is assumed that both play a role in prompting reactions from animals (Richardson et al. 1995).

As mentioned previously, hearing sensitivity isn't yet characterized in mysticetes, but based on their signals they are likely most sensitive at frequencies 10–10,000 Hz and therefore constitute a low-frequency functional hearing group (Southall et al. 2007). They typically emit signals with fundamental frequencies well below 1,000 Hz (Au et al. 2006; Cerchio et al. 2001; Munger et al. 2008) although non-song humpback signals have peak power near 800 and 1,700 Hz (Stimpert 2010) and humpback song harmonics extend up to 24,000 Hz (Au et al. 2006). While most mysticetes hear best at low frequencies, blue whales have been observed reacting to mid-frequency sound in the range of 3.5–3.6 kHz (Goldbogen et al. 2013). However, the responses varied across individuals and the responses themselves were strongly affected by the whale's behavioral state at the time of exposure, with surface feeding animals typically showing no change in behavior. By contrast, responses from deep feeding and non-feeding whales ranged from termination of deep foraging dives to prolonged mid-water dives. The potential impacts of ship noise can be assessed more confidently in odontocetes because they constitute mid-frequency or high-frequency functional hearing groups (Southall et al. 2007) in which auditory response curves have been obtained for many species. These curves show maximum auditory sensitivity near the frequencies where toothed whale signals have peak power (Mooney et al. 2012; Tougaard et al. 2014)—at about 1–20 kHz for social sounds and 10–100 kHz or higher for echolocation.

Marine mammals have been recorded in several instances altering and modifying their vocalizations to compensate for the masking noise from vessels, or other similar sounds (Holt et al. 2011; Parks et al. 2011). Vocal changes in response to anthropogenic noise can occur across the repertoire of sound production modes used by marine mammals, such as whistling, echolocation click production, calling, and singing. Changes to vocal behavior and call structure may result from a need to compensate for an increase in background noise. In cetaceans, vocalization changes have been reported from exposure to anthropogenic sources such as sonar, vessel noise, and seismic surveying. Behavioral responses to boat (as opposed to ship) noise have been documented in toothed whales. Bottlenose dolphins whistle (at 4–20 kHz) less when exposed to boat noise at 500–12,000 Hz (Buckstaff 2004) and Indo-Pacific bottlenose dolphins lower their 5–10 kHz whistle frequencies when noise is increased by boats in a band from 5,000 to 18,000 Hz (Morisaka et al. 2005). For every 1 dB increase in broadband underwater noise (1,000–40,000 Hz) associated with nearby boats, Southern Resident Killer whales compensated by increasing the amplitude of their most common call by 1 dB (Holt et al. 2008).

Vessel noise also has the potential to disturb marine mammals and elicit an alert, avoidance, or other behavioral reaction (Huntington et al. 2015; Pirotta et al. 2015; Williams et al. 2014). Most studies have reported that marine mammals react to vessel sounds and traffic with short-term interruption of feeding, resting, or social interactions (Huntington et al. 2015; Magalhães et al. 2002; Merchant et al. 2014; Pirotta et al. 2015; Richardson et al. 1995; Williams et al. 2014). In cases where vessels actively approached marine mammals (e.g., whale watching), scientists have documented that animals exhibit altered behavior such as increased swimming speed, erratic movement, and active avoidance behavior (Acevedo 1991; Baker and MacGibbon 1991; Bursk 1983; Constantine et al. 2003; New et al. 2015; Parsons 2012; Pirotta et al. 2015; Trites and Bain 2000; Williams et al. 2002), reduced blow interval (Richter et al. 2003), disruption of normal social behaviors (Lusseau 2003; Lusseau 2006; Pirotta et al. 2015), and the shift of behavioral activities which may increase energetic costs (Constantine et al. 2003; Constantine et al. 2004). These reactions could be caused by vessel noise or the presence of the vessel itself. Some species respond negatively by retreating or responding to the vessel antagonistically, while other animals seem to ignore vessel noises altogether (Watkins 1986). Marine mammals are frequently exposed to vessels due to research, ecotourism, commercial and private vessel traffic, and government activities. Veirs et al. (2016) measured ship noise in Puget Sound, Washington, and determined that median received spectrum levels of noise from 2,809 isolated transits are elevated relative to median background levels not only at low frequencies (20-30 dB re 1 mPa^2/Hz from 100 to 1,000 Hz), but also at high frequencies (5–13 dB from 10,000 to 96,000 Hz). Based on these results, noise received from ships at ranges less than 1.86 mi (3 km) could extend to frequencies used by odontocetes.

Studies showed that bowhead whales avoided encroaching vessels by as much as 2.5 mi (4 km), but returned to the displaced area within a day (Koski and Johnson 1987; Richardson et al. 1985). If vessels were not moving towards bowhead whales, bowhead whales did not demonstrate avoidance behaviors such as those described previously. Bowhead whales located more than 1,640 ft (500 m) behind the moving vessel did not demonstrate avoidance behavior and actually approached vessels to within 328 to 1,640 ft (100 to 500 m) (Wartzok et al. 1989). Therefore, it would appear that directionality and vessel speed could influence behavioral reactions of bowhead whales.

Other baleen whales, like the humpback whale, has exhibited varied responses to vessels, ranging from approaching to avoiding (Au and Green 2000; Baker and Herman 1989; Bauer and Herman 1986; Stamation et al. 2009). Vertical avoidance was observed within 1 mi (2 km), while horizontal avoidance occurred from 1–2 mi (2–4 km) away (Baker and Herman 1989; Baker et al. 1983). Humpback whales are less likely to react if actively engaged in feeding (Krieger and Wing 1984, 1986), although Blair et al. (2016) reported that humpback whales significantly changed foraging behavior in response to high levels of ship noise in the North Atlantic. Although vessels could cause some short-term changes in behavior, any disturbance is expected to be temporary and any exposed baleen whale is expected to return to its normal behavior after the vessel moves through the area.

Sperm whales have also exhibited varied responses to outboard vessels up to 1 mi (2 km) away (Cawthorn 1992). However, many individual sperm whales remained in areas with regular boat presence (Gordon et al. 1992). Smaller odontocetes, including some dolphins and porpoises and other smaller toothed whales (and occasionally sea lions and fur seals), interact with vessels by bow riding when a vessel is moving. Bow-riding is when the animals position themselves in such a manner as to be lifted up and pushed forward by the circulating water generated to form a bow pressure wave of an advancing vessel (Hertel 1969; Lang 1966).

Based on these studies, whales and dolphins are not expected to be disturbed by vessels that maintain a reasonable distance from them, though this varies with vessel size, geographic location, frequency of exposure, and tolerance levels of individuals. In addition, the Coast Guard would follow SOPs and BMPs described in Chapter 6 to minimize impact or harm to marine mammals.

Pinnipeds could react to vessels when hauled out, and thus reacting to both the in-air sound of a vessel as well as to the visual cue from the vessel itself. In 1997, Henry and Hammill (2001) conducted a study to measure the impact or harm of small boats (i.e., kayaks, canoes, motorboats and sailboats) on harbor seal haul out behavior in Metis Bay, Quebec, Canada and noted that the most frequent disturbances were caused by lower speed, lingering kayaks, and canoes as opposed to motorboats conducting high speed passes. The study concluded that boat traffic at current levels had only a temporary effect on the haul out behavior of harbor seals in the Metis Bay area because once the animals were disturbed, there did not appear to be any significant lasting effect on the recovery of numbers to their pre-disturbance levels.

Pinnipeds may also react to vessels while they are in the water, from hearing just the in-water vessel noise or hearing the in-water vessel noise and the sight of the vessel approaching (only likely if the pinniped's head is above water). Richardson et al. (1995) stated that for in-water vessel reactions only, pinnipeds are much less likely to react to vessels if they are in water and not hauled out. While in water, pinnipeds show a high tolerance to vessels, though it is not known if these incidents cause them stress, despite their tolerance (Richardson et al. 1995). Johnson and Acevedo-Gutierrez (2007) evaluated the efficacy of buffer zones for watercraft around harbor seal haulout sites on Yellow Island, Washington. The authors estimated the minimum distance between the vessels and the haulout sites, categorized the vessel types, and evaluated seal responses to the disturbances. During the course of the seven-weekend study, the authors recorded 14 human-related disturbances, which were associated with stopped powerboats and kayaks. During these events, hauled out seals became noticeably active and moved into the water. The flushing occurred when stopped kayaks and powerboats were at distances as far as 453 and 1,217 ft (138 and 371 m), respectively. The authors note that the seals were unaffected by passing powerboats, even those approaching as close as 128 ft (39 m), possibly indicating that the animals had become tolerant of the brief presence of the vessels and ignored them. The authors reported that on average, the seals quickly recovered from the disturbances and returned to the haulout site in less than or equal to 60 minutes. The study concluded that the return of seal numbers to pre-disturbance levels and the relatively regular seasonal cycle in abundance throughout the study area, counter the idea that disturbances from powerboats may result in site abandonment (Johnson and Acevedo-Gutiérrez 2007). Frequent and close disturbances may cause abandonment of a haulout site (Allen et al. 1984), but are not likely to occur from infrequent exposure to boats passing by the haulout. In general, from the available information, pinnipeds exposed to intense (approximately 110 to 120 dB re 20 μPa @ 1 m) non-pulsed sounds often leave haulout areas and seek refuge temporarily (minutes to a few hours) in the water (Southall et al. 2007).

In recorded observations, polar bears do not appear to be significantly affected by vessel noise and/or presence. Some polar bears have been observed walking, running, and swimming away from approaching vessels, but these reactions were brief and localized. Other polar bears have been observed approaching vessels or having no reaction to vessels (Richardson et al. 1995).

The received levels (see Appendix B) from sources and associated source levels (Table 4-2) from vessel noise from the Proposed Action are expected to be below the onset of TTS and PTS (Table 4-3) for all marine mammal groups, including mysticetes, odontocetes, pinnipeds, or polar bears, that may be within the proposed action areas. Underwater vessel noise from a PIB or associated support vessels could overlap with the same low-frequency sounds that many whales use for communication for feeding and mating, and therefore, could cause masking. Auditory response curves for odontocetes show maximum auditory sensitivity near where toothed whale signals have peak power (Mooney et al. 2012; Tougaard et al. 2014) at about 1,000–2,000 Hz for social sounds and 10,000–100,000 Hz or higher for echolocation. NMFS (2016c) considers sperm whales to be MF cetaceans with a generalized hearing range from 150 Hz to 160 kHz, and pinnipeds as PW with a generalized hearing range from 50 Hz to 86 kHz or OW with a generalized hearing range from 60 Hz to 39 kHz.

Commercial ships radiate noise underwater with peak spectral power at 20–200 Hz (Ross 1976). The dominant noise source is usually propeller cavitation which has peak power near 50–150 Hz (at blade rates and their harmonics), but also radiates broadband power at higher frequencies, at least up to 100,000 Hz (Arveson and Vendittis 2000; Gray and Greeley 1980; Ross 1976). While propeller singing is caused by blades resonating at vortex shedding frequencies and emits strong tones between 100 and 1,000 Hz, propulsion noise is caused by shafts, gears, engines, and other machinery and has peak power below 50 Hz (Richardson et al. 1995). Overall, larger vessels generate more noise at low frequencies (<1,000 Hz) because of their relatively high power, deep draft, and slower-turning (<250 rotations per minute) engines and propellers (Richardson et al. 1995).

Odontocetes and pinnipeds are not expected to be impacted or harmed, by the low-frequency noise produced by ships because the noise produced is outside of the typical hearing range for odontocetes and pinnipeds. However, Veirs et al. (2016) noted that median received spectrum levels of noise from 2,809 isolated transits were elevated relative to median background levels including high frequencies (5–13 dB from 10,000 to 96,000 Hz). Thus, noise received from ships at ranges less than 3 km extends to frequencies used by odontocetes (e.g., killer whales). As these ships enter shallow waters and traverse the estuarine habitat typically occupied by major ports, the noise they radiate may impact coastal marine life. It is expected, that the PIBs would avoid areas where odontocetes, specifically Southern Resident killer whales, are expected.

It is expected that vessels associated with the Proposed Action, similar to other ships transiting through the proposed action areas, would not be expected to alter current levels of ambient noise. Any increase in ambient noise as a result of a PIB would be temporary and localized to the position of the vessel as it moves throughout the proposed action areas. Masking impacts would be similar to what is currently present in the proposed action areas, because the proposed action activities are not expected to change the current ambient noise levels. Coast Guard would follow SOPs and BMPS (see Chapter 6) and vessels would not purposefully approach marine mammals. The noise generated by these vessels are not expected to elicit significant behavioral responses to exposed individuals. Such reactions would not be expected to significantly disrupt behavioral patterns such as migration, breathing, nursing, breeding, feeding and sheltering to a point where the behavior pattern is abandoned or significantly altered or result in reasonably foreseeable takes of marine mammals.

Vessel noise associated with the Proposed Action would not result in significant impacts to marine mammals or result in significant harm to marine mammals. Pursuant to the ESA, vessel noise associated with the Proposed Action may affect, but is not likely to adversely affect ESA-listed blue whale, bowhead whale, fin whale, gray whale, humpback whale, North Pacific right whale, polar bear, sei whale, Southern Resident killer whale, sperm whale, bearded seal, ringed seal, and Steller sea lion. Although vessel noise would have a greater potential impact underwater, than above water, it would not have significant effects on those critical habitat characteristics, such as sea ice, essential to ESA-listed polar bears and ringed seals. Vessel noise would be temporary and transient and associated with vessel movement, and therefore, should a PIB need to transit critical habitat areas, vessel noise would not be expected to impact the aquatic critical habitat designated for the North Pacific right whale, Southern Resident killer whale, or Steller sea lion for a prolonged period (less than a few hours). The resources essential to the conservation of ESA-listed marine mammals would not be significantly impacted by vessel noise. Vessel noise would not result in the destruction or adverse modification of federally-designated critical habitat. Vessel noise would not result in the destruction or adverse modification of federally-designated critical habitat because critical habitat would be avoided for the North Pacific right whale, Southern Resident killer whale, Steller sea lion, polar bear, or the proposed critical habitat of the ringed seal.

4.1.3.6 Impacts from Vessel Noise Under the Alternatives 2 and 3

Alternative 2: Leasing

It is assumed that vessel noise from a leased vessel would be similar to what is in current use and the potential impact would be similar to what was analyzed under Alternative 1. Therefore, the potential impacts associated with vessel noise under Alternative 2 are the same as under Alternative 1. Therefore, vessel noise from Alternative 2 is not likely to significantly impact or result in significant harm to invertebrates, fish, birds, sea turtles, and marine mammals.

Alternative 3: No Action

Under the No Action Alternative, the Coast Guard would fulfill its missions in the Arctic and Antarctic using existing polar icebreaker assets, which are reaching the end of their service lives. The current polar icebreaker fleet would continue current operations. Therefore, as long as the current polar icebreaker fleet is operational, baseline conditions of the existing environment would remain unchanged and would not significantly impact or result in significant harm to invertebrates, fish, birds, sea turtles, and marine mammals. Once the current fleet of icebreakers are decommissioned and no longer in operation, the Coast Guard would no longer have polar icebreakers in their fleet and therefore, operations and training from a polar icebreaker would no longer occur.

4.1.4 Icebreaking Noise

Marine species within the Arctic and Antarctic proposed action areas may be exposed to icebreaking noise associated with the Coast Guard's icebreaker's activities. Icebreaking noise is generally described as a low frequency, 10 to 100 Hz (Roth et al. 2013), non-impulsive sound (Appendix A). Icebreaking noise, as modeled for the marine mammals (Appendix A), is a combination of the sounds made by the vessel's engine and propeller while icebreaking and the sound(s) created by the breaking of ice. A more detailed description of the modeling of icebreaking noise can be found in Appendix A and in Roth et al. (2013). Icebreaking could occur in the Arctic and Antarctic proposed action areas at various times (seasons), when ice thickness is expected to be at or near its lowest levels, which would minimize the timeframe (duration) in which icebreaking would occur. Ice, however thin, doesn't fracture by itself, but wind, pressure systems, and ocean gyres transport ice and often cause fractures to form. Therefore, cracks are a regular feature of ice. Ambient sound levels (of natural ice sounds) can vary greatly from season to season in a particular location due to environmental conditions (such as sea ice, temperature, wind, and snow) and the presence of marine life and other anthropogenic sound. Burgess and Greene Jr. (1999) found that ambient sound levels in the Beaufort Sea in the month of September ranged from 63 to 133 dB re 1 µPa. Any increase in ambient noise from icebreaking would be temporary and localized to where the icebreaker is positioned and as it moves through the icebreaking area.

During icebreaking operations, vessel speed would range from 3 to 6 knots. In heavier pack ice or thick landfast ice, an icebreaker would operate at a maximum speed of 3 knots, but engine power levels would be higher, which would be expected to increase the sound produced by the icebreaker (Slabbekoorn et al. 2010). In loose pack ice, the speed and noise of an icebreaker would be similar to the speed and noise produced when the vessel is transiting in the open ocean (at roughly 12 knots). Icebreaking associated with the Proposed Action would be short-term and transitory as the vessel moves through an area. The type of ice in the Arctic and Antarctic proposed action areas would influence the type of organisms present and their reaction to icebreaking.

Icebreaking noise associated with the Proposed Action would not result in significant impacts or result in harm to invertebrates, seabirds, fish, and marine mammals. There would be no impact or harm to sea turtles from icebreaking noise as their range does not overlap with the Arctic or Antarctic proposed action areas where icebreaking would take place. Icebreaking noise associated with the Proposed Action would not alter the physical or biological features essential to the conservation of any ESA-listed species; therefore, vessel noise associated with the Proposed Action is not expected to result in the destruction or adverse modification of federally-designated critical habitat. There would be no impact or harm to

EFH from icebreaking noise. Pursuant to the ESA, icebreaking noise associated with the Proposed Action may affect, but is not likely to adversely affect the ESA-listed blue whale, bowhead whale, humpback whale, polar bear, sei whale, bearded seal, and ringed seal. The potential effects of icebreaking noise are discussed in detail below.

4.1.4.1 Invertebrates

Icebreaking noise is generally described as a low frequency, 10 to 100 Hz (Roth et al. 2013), non-impulsive sound (Appendix A). Similarly, vessel noise is also characterized as low frequency. As such, a species response to icebreaking noise would be expected to be similar to their response to vessel noise. Invertebrates, such as many of the crustaceans and some of the cephalopods would be expected to hear in the icebreaking frequency range, and, if close enough to the source, might exhibit avoidance behavior or other short term temporary responses (such as feeding cessation, increased stress, or other minor physiological impacts) (Edmonds et al. 2016; Roberts and Breithaupt 2016). Masking is also possible, but less likely due to the impulsive nature of the source. Since exposure would be expected to be short term, of low intensity, and infrequent, recovery would be expected and no long-term changes in behavior or distribution, or population level effects would be anticipated.

Icebreaking noise associated with the Proposed Action would not result in significant impacts to invertebrates or result in significant harm to invertebrates. There are no ESA-listed invertebrates within the proposed action areas.

4.1.4.2 Fish

Icebreaking noise is generally described as a low frequency, 10 to 100 Hz (Roth et al. 2013), non-impulsive sound (Appendix A). Similarly, vessel noise is also characterized as low frequency. As such, a species response to icebreaking noise would be expected to be similar to their response to vessel noise. Low frequency sounds can be heard and also felt by many fish species. If a fish is close enough to the source, individuals might exhibit avoidance behavior or other short term temporary responses (such as feeding cessation, increased stress, or other minor physiological impacts) (Slabbekoorn et al. 2010). Masking is also possible, but any impacts from masking would be temporary. Since exposure would be expected to be short term and temporary, rapid recovery would be expected, and no long-term changes in behavior or distribution, or population level effects would be anticipated.

Icebreaking noise associated with the Proposed Action would not result in significant impacts to fish or result in significant harm to fish. Pursuant to the ESA, there would be no effect to ESA-listed bocaccio, Chinook salmon, chum salmon, coho salmon, Pacific eulachon, sockeye salmon, steelhead trout, or yelloweye rockfish from icebreaking associated with the Proposed Action, as these species do not overlap with areas where icebreaking would be expected (e.g., where temporary or permanent sea ice). There would be no effect to critical habitat for ESA-listed fish species because the proposed action areas are outside of designated critical habitat.

4.1.4.3 Seabirds and Shorebirds

Icebreaking noise is generally described as a low frequency, 10 to 100 Hz (Roth et al. 2013), non-impulsive sound (Appendix A). While Godin (2006) states that the air-water interface is nearly transparent when it comes to the transmission of low-frequency sound, this is not within the range of best hearing for birds in air. In addition, any noise associated with icebreaking by a PIB, both in-air and underwater, would likely fall within the spectrum of natural ice-related sounds expected in the polar environment. Thus, icebreaking noise is unlikely to be detected by seabirds, either in air or if the sound transmission carries underwater.

Icebreaking noise associated with the Proposed Action would not alter the physical or biological features essential to the conservation of ESA-listed spectacled eider and Steller's eider. Physical or biological features associated with Emperor and Adélie penguin habitat would not be permanently altered by the Proposed Action, as icebreaking would be infrequent (one patrol per year and icebreaking would only occur, as necessary) in the Antarctic proposed action area and once the icebreaker has ceased icebreaking, ice would be expected to reform. Any increase in ambient noise as a result of the icebreaking would be temporary and localized to the position of the vessel as it moves throughout the proposed action area. As icebreaking noise is outside of the range of hearing of seabirds, it is not expected that icebreaking noise would be detected by seabirds.

Icebreaking noise associated with the Proposed Action would not result in significant impacts to birds or result in significant harm to birds. As icebreaking noise is outside of the range of hearing of seabirds, it is not expected that icebreaking noise would be detected by seabirds. Therefore, pursuant to the ESA, there would be no effect to the ESA-listed short-tailed albatross, spectacled eider, or Steller's eider from icebreaking noise. Icebreaking noise would have no effect on the ESA-listed marbled murrelet as their range does not overlap with areas where icebreaking would be expected (e.g., where temporary or permanent sea ice). Icebreaking noise would not result in the destruction or adverse modification of federally-designated critical habitat of the spectacled or Steller's eider. Pursuant to the MBTA, icebreaking noise associated with the Proposed Action would not result in a significant adverse effect on migratory bird populations. Icebreaking noise would also have no effect on penguins in the proposed action area because it is outside of hearing range.

4.1.4.4 Marine Mammals

Icebreaking noise is generally described as a low frequency, 10 to 100 Hz (Roth et al. 2013), non-impulsive sound (Appendix A). A quantitative analysis of the potential effects to marine mammals from icebreaking noise, including the ESA-listed polar bear, was conducted using a method that calculates the total sound exposure level and maximum SPL that a marine mammal may receive from icebreaking. The Coast Guard used the Navy Acoustic Effects Model (NAEMO) to model icebreaking (see Appendix B for more detail).

Acoustic characteristics for icebreaking were derived from the 2013 study of CGC HEALY conducted in the central Arctic Ocean (Roth et al. 2013). This study provided sound signatures of the icebreaker in 8/10 ice coverage and 3/10 ice coverage, which were used to correspond to full power and quarter power ice breaking, respectively. Roth et al. (2013) analyzed the CGC HEALY as it traveled from the open ocean through ice to an open polynya. The 8/10s ice cover (and above) represented the noise made by backing and ramming of CGC HEALY in heavy ice cover; therefore, this noise was used to model icebreaking in heavy ice cover. The 3/10s ice cover in the Roth et al. (2013) represented lighter ice coverage, for which there was a different acoustic signature. The synopsis of hours spent icebreaking at each power was provided from Coast Guard cruise reports (U.S. Coast Guard) and corresponds to the varying amounts of ice cover encountered over the duration of one patrol period in each Polar Region. Therefore, icebreaking was modeled using the 8/10s signature for all full power and half power icebreaking, while the 3/10s signature was used for the hours spent icebreaking at a quarter power. Appendix B provides further detail on the acoustic modeling for icebreaking noise.

4.1.4.4.a Quantitative Analysis

Environmental characteristics (e.g., bathymetry, wind speed, and sound speed profiles) and source characteristics (i.e., source level, source frequency, interval, and source depth) were used to determine the propagation loss of the acoustic energy, which was calculated using the Comprehensive Acoustic System Simulation/Gaussian Ray Bundle (CASS/GRAB) propagation model (see Appendix B). Additionally, an under-ice model (Oceanographic and Atmospheric Master Library [OAML] ICE) for surface interaction was implemented in NAEMO (Appendix B). The propagation loss then was used in NAEMO to create acoustic footprints. The NAEMO model then simulated source movement through a "representative modeling box" in each region (Arctic and Antarctic) where icebreaking would most likely occur to allow the model to run simulations in a specific area and calculated sound energy levels around the source. The representative model included the open water, the ice edge, and ice-covered areas. A PIB may or may not remain in the area that is represented by this "representative modeling box," but for the purposes of modeling, this "representative modeling box" did provide a geographic area and ice conditions that would be similar to the icebreaking conditions that a PIB would be expected to operate in. Animats, or representative animals, were distributed based on density data obtained from the Navy Marine Species Density Database (U.S. Navy 2014a). Because occurrence information for marine mammal species is unknown, a uniform year-round distribution was applied. The majority of the Arctic species used a Seasonal Relative Environmental Suitability (RES) model (Kaschner et al. 2006), based on seasonal habitat preferences and requirements of known occurrences, such as temperature, bathymetry, and distance to land data and literature review, but where possible, recent scientific literature that included distance sampling or mark recapture was used to validate the density values estimated using the RES model (Appendix B). In the Antarctic, data was even less reliable, but RES density estimates were incorporated, and when possible, recent scientific literature including distance sampling and aerial/ship transect survey data were used to validate the density values estimated using the RES model (Appendix B). Empirical data was coupled with RES modeling data to generate predictions of density data for locations where no survey data exist. The energy received by each animat distributed within the model was summed into a total sound exposure level. Additionally, the maximum SPL received by each animat was also recorded. NAEMO also incorporated the number of days and hours of icebreaking during the Antarctic and Arctic missions (Table 4-4).

Table 4-4. Total Number of Days and Hours Each Day that a PIB Would Be Expected to Ice Break or Tow a Vessel in Ice in the Arctic and Antarctic Proposed Action Areas

Icebreaking	Antarctic Mission		Arctic Mission	
	Number of Days	Number of Hours each day	Number of Days	Number of Hours each day
8/10s ice cover	4	16	10	16
3/10s ice cover	22	16	11	16
Vessel Tow in Ice				
	1	4	X	X

NAEMO provides two outputs. The first is the number of animats recorded with received levels within 1 dB bins at and greater than 120 dB re 1 μPa and the total sound exposure level (in dB re 1 $\mu Pa^2 \cdot s$) for each animat, prior to effect thresholds being applied (referred to as unprocessed animat exposures). These results are used to determine if a marine mammal may be exposed to the acoustic energy resulting from the Proposed Action, but they do not infer that any such exposure results in an effect to the animal from the action. The second output, referred to as calculated exposures, is the predicted number of exposures that could result in effects as determined by the application of acoustic threshold criteria. Criteria and thresholds for measuring these effects induced from underwater acoustic energy have been established for cetaceans and pinnipeds. The thresholds established for physiological effects (sound exposure levels for PTS and TTS) and behavioral effects are provided in Table 4-3 and are described in detail in National Marine Fisheries Service (National Marine Fisheries Service 2016c, 2018).

Behavioral response criteria are used to estimate the number of exposures that may result in a behavioral response. The Navy has defined a mathematical function used to predict potential behavioral effects (see Appendix B). This analysis assumes that the probability of eliciting a behavioral response from individual animals to active transmissions would be a function of the received SPL (dB re 1 µPa). This analysis also assumes that sound poses a negligible risk to marine mammals if they are exposed to SPLs below a certain basement value (120 dB re 1 µPa). Details regarding the behavioral risk function are provided in U.S. Navy (2017b). The output from the acoustic model is the calculated number of marine mammals exposed at or above acoustic effects thresholds listed in Table 4-5 and Table 4-6.

1 **Table 4-5. Marine Mammal Acoustic Exposure from Icebreaking Noise in the Arctic and**
2 **Antarctic Proposed Action Areas**

Common Name	Behavioral		TTS		PTS	
	8/10s ice cover	3/10s ice cover	8/10s ice cover	3/10s ice cover	8/10s ice cover	3/10s ice cover
Mysticetes						
Arctic						
Bowhead whale	1	1	0	0	0	0
Antarctic						
Antarctic minke whale	49	224	0	0	0	0
Blue whale	3	12	0	0	0	0
Humpback whale	13	59	0	0	0	0
Minke whale	50	237	0	0	0	0
Odontocetes						
Antarctic						
Arnoux's beaked whale	50	275	0	0	0	0
Gray's beaked whale	5	29	0	0	0	0
Killer whale	45	169	0	0	0	0
Southern bottlenose whale	44	243	0	0	0	0
Pinnipeds and Carnivores						
Arctic						
Bearded seal	42	41	0	0	0	0
Polar bear	13	14	0	0	0	0
Ringed seal	764	810	0	0	0	0
Antarctic						
Crabeater seal	404	1962				
Leopard seal	23	117	0	0	0	0
Ross seal	15	75	0	0	0	0
Weddell seal	18	90	0	0	0	0

Table 4-6. Marine Mammal Acoustic Exposure from Icebreaking Noise during Vessel Escort and Towing in the Antarctic Proposed Action Area

Common Name	Behavioral		TTS		PTS	
	8/10s ice cover	3/10s ice cover	8/10s ice cover	3/10s ice cover	8/10s ice cover	3/10s ice cover
Mysticetes						
Antarctic minke whale	65	4	0	0	0	0
Blue whale	4	1	0	0	0	0
Humpback whale	17	1	0	0	0	0
Minke whale	67	4	0	0	0	0
Odontocetes						
Arnoux's beaked whale	70	10	0	0	0	0
Gray's beaked whale	7	1	0	0	0	0
Killer whale	55	4	0	0	0	0
Southern bottlenose whale	61	9	0	0	0	0
Strap-toothed whale	24	3	0	0	0	0
Pinnipeds						
Leopard seal	28	2	0	0	0	0
Ross seal	17	2	0	0	0	0

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

4.1.4.4.b Qualitative Analysis

No research has been conducted on the potential behavioral responses of marine mammals to icebreaking noise, though some observations, primarily of pinnipeds out of water, have been recorded and are discussed in Richardson et al. (1995). When compared to ships in open water (versus an icebreaker in ice), Richardson et al. (1995) observed that pinnipeds out of water may be able to detect the vessels in ice from a greater distance.

Some data are available on the effects of non-impulsive sources (icebreaking is considered a non-impulsive source) on some marine mammals in water, and the reactions of specific marine mammals (e.g., ringed seals while in subnivean lairs). All of this available information was assessed and incorporated into the findings of this analysis. Section 4.1.2.3 provides general information on non-impulsive sources that would also be applicable here, as icebreaking and vessel towing were modeled as a non-impulsive source. The assumption with vessel towing was that icebreaking would occur during the tow, but the discussion below on icebreaking would also apply, although to a lesser extent, during a vessel tow.

The behavioral response function is limited in that it only differentiates behavioral responses based on one variable, the received level of sound. However, many other variables such as the marine mammal's gender, age, the activity it is engaged in during a sound exposure, its distance from a sound source, the number of sound sources, and whether the sound sources are approaching or moving away from the animal can be critically important in determining whether and how a marine mammal would respond to a sound source (Southall et al. 2007). Furthermore, the behavioral response function does not differentiate between different types of behavioral reactions (e.g., area avoidance, diving avoidance, or alteration of natural behavior) or provide information regarding the predicted consequences to the animal of the reaction. At present, available data do not allow for incorporation of these other variables in the current behavioral response function; they must be assessed qualitatively.

Effects of Non-Impulsive Sources (icebreaking and vessel tow)

Modeling results indicate that icebreaking and vessel tow noise would result in behavioral exposures to bowhead whales, minke whales, blue whales, and humpback whales; the Arnoux's beaked whale, killer whale, and Southern bottlenose whale; and, the bearded seal, polar bear, ringed seal, leopard seal, and Ross seal. Modeling results also indicate that vessel tow (only in the Antarctic) would result in behavioral exposures to minke whales, blue whales, humpback whales; the Arnoux's beaked whale, killer whale, and Southern bottlenose whale; and, the leopard seal and Ross seal. In Antarctica, minke and killer whales are expected to be present at higher concentrations along the ice edge (SCAR 2002). In general, most species except for the killer whale migrate north in the middle of the austral winter and return to Antarctica in the early austral summer. Due to the area where icebreaking would take place (initiating at the ice edge and then breaking into the thicker ice areas), transmission loss, and proximity to the ice edge, it is expected that most exposures to cetaceans would be minimal, particular over the short duration that icebreaking is expected to occur. In addition, it is unlikely that an individual animal would remain near the icebreaker for the entire time it is icebreaking. As part of the Coast Guard's SOPs and BMPs (see Chapter 6), a trained lookout would observe for marine mammals (both ESA-listed; and those protected under the MMPA, Antarctic Treaty, and CITES) and communicate any sightings with the Commanding Officer to minimize any potential impacts associated with the Proposed Action.

Given the many uncertainties in predicting the quantity and types of impacts sound may have on marine mammals, and the lack of abundance estimates and population trend data for marine mammals in the Southern Hemisphere and for several species in the Arctic Region, the conservative approach was used to estimate how many marine mammals would be encountered during the icebreaking period and/or exposed to icebreaking noise. This approach likely overestimates the numbers of marine mammals that would be affected in a biologically important manner (results in Table 4-5 and Table 4-6). The sound criteria used to estimate how many marine mammals might be disturbed to some biologically important degree by underwater noise, are based primarily on behavioral observations of a few species, but for most marine mammal species there are no data on responses to icebreaking or vessel tow noise. Therefore, the assessment relies on what is known about a marine mammal's response to other non-impulsive sound sources.

As mentioned previously, hearing sensitivity isn't yet characterized in mysticetes, but based on their vocalizations they are likely most sensitive at frequencies 10–10,000 Hz and therefore, constitute a low-frequency functional hearing group (Southall et al. 2007). The potential impacts of icebreaking noise can be assessed more confidently in odontocetes because they constitute mid-frequency or high-frequency functional hearing groups (Southall et al. 2007) in which auditory response curves have been obtained for many species. These curves show maximum auditory sensitivity near the frequencies where toothed whale signals have peak power (Mooney et al. 2012; Tougaard et al. 2014)—at about 1,000–20,000 Hz for social sounds and 10,000–100,000 Hz or higher for echolocation.

Based on the studies discussed in Section 4.1.4.4, exposure to icebreaking and vessel tow noise would not result in PTS and TTS in cetaceans. Although cetaceans' exposure to icebreaking and vessel towing may cause a behavioral response, the Coast Guard would follow SOPs and BMPs described in Chapter 6 to minimize impact or harm to marine mammals. A cetacean's behavioral response would vary by individual, but the most severe response would result in avoidance of the icebreaking or vessel tow area, but this avoidance would be expected to be temporary. The acoustic modeling does not account for seals within subnivean lairs or those that are hauled out, 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 pinnipeds are expected to be hauled out or, in the case of ringed seals in the Arctic, 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 or at a haulout site), the best hearing sensitivity for a ringed seal, for example, has been documented between 3 and 5 kHz; at higher frequencies, the hearing threshold rapidly increases (Sills et al. 2015). This same general decrease due to sound attenuation would also be expected for any other pinnipeds in the proposed action areas, as well.

Data suggest that exposures of pinnipeds to non-impulsive sources between 90 and 140 dB re 1 μPa do not elicit strong behavioral responses (Southall et al. 2007). Additional data on hooded seals indicate avoidance responses to signals above 160–170 dB re 1 μPa (Kvadsheim et al. 2010), and data on grey and harbor seals indicate avoidance response at received levels of 135–144 dB re 1 μPa (Götz and Janik 2010). In each instance where food was available, which provided the seals motivation to remain near the source, habituation to the signals occurred rapidly.

Seals exposed to non-impulsive sources with a received SPL within the range of calculated exposures, (142–193 dB re 1 μPa), have been shown to change their behavior by modifying diving activity and avoidance of the sound source (Götz and Janik 2010; Kvadsheim et al. 2010). Although behavioral responses may occur as a result of exposure to icebreaking noise in the Proposed Action, these changes would be within the normal range of behaviors for the animal (e.g., the use of a breathing hole further from the source, rather than one closer to the source, would be within the normal range of behavior) (Kelly et al. 1988). However, based on the modeling results, the Coast Guard would apply for authorization to take marine mammals by harassment under the MMPA.

Ringed seal pups spend about 50 percent of their time in a subnivean 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 (Chapskii 1940; McLaren 1958; Smith and Stirling 1975). If the icebreaking noise is 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 (*Vulpes lagopus)* (their primary predators), although the type of sound would be novel to them. 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 icebreaking noise is unlike the low frequency sounds and vibrations felt from approaching predators. Additionally, the icebreaking noise is 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 noise (Elsner et al. 1989; Wartzok et al. 1992a).

It is anticipated that a ringed seal or any other pinniped in the proposed action areas would be able to relocate to a different breathing hole relatively easily without impacting their normal behavior patterns. Similarly, polar bears would be expected to exhibit a behavioral response, such as avoidance. Like a subnivean lair, a polar bear inhabiting a den may perceive the icebreaking noise, but any behavioral reaction is expected to be temporary and they would subsequently reoccupy the den.

4.1.4.4.c Summary of Icebreaking Impacts or Harm to Marine Mammals

The behavioral responses of cetaceans and pinnipeds to underwater sound vary. Non-impulsive sources have been shown to elicit minor or moderate avoidance responses. For example, an individual marine mammal's potential behavioral response from icebreaking noise could be an alert or temporary avoidance of the icebreaking area (e.g., a ringed seal could use a breathing hole/lair further from the icebreaker or a whale could change its swimming route). Data show that likely reactions would be within the normal repertoire of the animal's typical movements. Icebreaking noise would not result in the abandonment of a haulout site. These and similar reactions would not disrupt the animal's overall behavioral pattern (e.g., feeding or nursing), and would therefore not affect the animal's ability to survive, grow, or reproduce.

As described above, the sound sources in the Proposed Action are expected to result in, at most, minor to moderate behavioral avoidance responses, over short and intermittent periods of time. The Proposed Action is not expected to cause significant disruptions such as flushing from haulouts, or abandonment of breeding, that would result in significantly altered or abandoned behavior patterns. Since the icebreaking noise from the Proposed Action may cause behavioral responses (e.g., a marine mammal temporarily avoiding an area) the Coast Guard would request authorization under the MMPA from NMFS and the USFWS for Level B take of marine mammals in accordance with MMPA.

Icebreaking noise associated with the Proposed Action would not result in significant impacts or result in significant harm to marine mammals. Pursuant to the ESA, icebreaking noise associated with the Proposed Action would have no effect on ESA-listed fin whale, gray whale, North Pacific right whale, Southern Resident killer whale, bearded seal, ringed seal, and Steller sea lion as their range does not overlap with areas where icebreaking would be expected (e.g., where temporary or permanent sea ice). The Proposed Action may affect, but is not likely to adversely affect ESA-listed blue whale, bowhead whale, humpback whale, polar bear, sei whale, bearded seal, and ringed seal. Although icebreaking noise would have a greater potential impact underwater, than above water, it would not have significant effects on those critical habitat characteristics, such as sea ice, essential to ESA-listed polar bears and ringed seals. Icebreaking noise would be temporary and transient and associated with vessel movement and would occur in areas outside of designated critical habitat for the North Pacific right whale, Southern Resident killer whale, and Steller sea lion. The resources essential to the conservation of ESA-listed marine mammals would not be significantly impacted by icebreaking noise. Icebreaking noise would not result in the destruction or adverse modification of federally-designated critical habitat for the North Pacific right whale, Steller sea lion, Southern Resident killer whale, or the proposed critical habitat of the ringed seal.

4.1.4.5 Impacts from Icebreaking Noise Under the Alternatives 2 and 3

Alternative 2: Leasing

It is assumed that icebreaking noise from a leased vessel would be similar to what is in current use and the potential impact would be similar to what was analyzed under Alternative 1. Therefore, the potential impacts associated with icebreaking noise under Alternative 2 are the same as under Alternative 1. Therefore, icebreaking noise from Alternative 2 is not likely to significantly impact or result in significant harm to invertebrates, fish, birds, and marine mammals.

Alternative 3: No Action

Under the No Action Alternative, the Coast Guard would fulfill its missions in the Arctic and Antarctic using existing polar icebreaker assets, which are reaching the end of their service lives. The current polar icebreaker fleet would continue current operations. Therefore, as long as the current polar icebreaker fleet is operational, baseline conditions of the existing environment would remain unchanged and would not significantly impact or result in significant harm to invertebrates, fish, seabirds, and marine mammals. Once the current fleet of icebreakers are decommissioned and no longer in operation, the Coast Guard would no longer have polar icebreakers in their fleet and therefore, operations and training from a polar icebreaker would no longer occur.

4.1.5 Aircraft Noise

The primary aircraft expected to be used during the Proposed Action is the MH-60 Jayhawk helicopter; however, the Coast Guard may also use UAVs for ice reconnaissance. The MH-60 Jayhawk is an all-weather, medium-range helicopter (specialized for search and rescue). Helicopter flights associated with the Proposed Action would occur in both the Arctic and Antarctic proposed action areas and would be used for transport of personnel and equipment and for conducting training (e.g., qualifications). In general, flights can occur at 400–1,500 ft (122–457 m) in altitude, but typically, aircraft stay at or above 1,000 ft (305 m), when possible. Aircraft would not operate at an altitude lower than 1,500 ft (457 m) within 0.5 mi (805 m) of marine mammals observed on ice or land. Helicopters would also not hover or circle above such areas. Per the Coast Guard Air Operations Manual (COMDTINST M3710.1G), aircraft would avoid any identified environmentally sensitive areas, to include, but not be limited to, critical habitat designated under the ESA, migratory bird sanctuaries, and marine mammal haulouts and rookeries, but if deemed necessary (e.g., personnel safety) to pass over such areas, aircraft would stay above 3,000 ft (914 m).

Aircraft conducting search and rescue searches for persons in the water or a vessel in distress, may require that the helicopter fly at an altitude below 500 ft (152 m). Emergency recovery of persons in the water and transfer of rescue equipment would also require that the helicopter hover below 500 ft (152 m). Any Coast Guard response during a search and rescue mission is considered an emergency and is not a part of the Proposed Action (see Section 2.1.4). However, normal operations and training for a SAR is part of the Proposed Action. As stated previously, environmentally sensitive areas would be avoided and flights would be expected to stay above 1,500 ft (457 m). Any SAR training that may require helicopters to fly below 1,500 ft (457 m), would avoid environmentally sensitive areas, critical habitat, migratory bird sanctuaries, marine mammal haulouts and rookeries, and areas where ESA-listed species are known to occur, and would follow the Coast Guard's SOPs and BMPs (see Chapter 6).

Helicopters produce low-frequency sound and vibration (Pepper et al. 2003; Richardson et al. 1995). Noise generated from helicopters is transient in nature and variable in intensity. Helicopter sounds contain dominant tones from the rotors that are generally below 500 Hz. MH-60 noise levels at the helicopter average approximately 136 dB re 20 µPa in air with frequencies between 20 Hz and 5 kHz.

More low frequency components (<1 kHz) are contained in this broad band signal primarily from rotor noise (i.e., helicopter blade rotation). Helicopters often radiate more sound forward than aft.

Sound levels generated by UAVs have not been well-documented. However, two multi-rotor UAVs were measured to produce broad-band in-air source levels of 80 dB re 20 µPa with frequencies centered at 60 to 150 Hz. When flying at altitudes of 16 to 33 ft (5 to 10 m) above the water's surface, the received levels of these UAVs were considered to be close to ambient noise levels in many shallow water habitats and below the hearing thresholds of most marine species (Christiansen et al. 2016). A fixed-wing UAV is expected to be quieter than quad-copters and would operate at a minimum altitude of 3,000 ft (914 m) above the water's surface. Similar to the helicopters, UAVs would avoid any identified environmentally sensitive areas, to include, but not limited to, critical habitat designated under the ESA, migratory bird sanctuaries, and marine mammal haulouts and rookeries.

Potential impact or harm to species from aircraft could involve acoustic and non-acoustic effects (see Section 4.2.2 for a discussion on aircraft and in-air device movement) and it is unclear if reactions are due to sound or the physical presence of the aircraft flying overhead. The noise associated with aircraft needs to be considered in multiple ways: in-air, on the sea surface, under ice (if applicable), and underwater. Aircraft generate noise in flight, which propagates through the air, which may be detected by species above water. This sound can also interact with the ice surface and potentially propagate through ice into the water. Underwater helicopter noise may be detected by species that dive or forage below the water's surface. However, for some species the amount of time spent underwater may be extremely limited, decreasing the potential for impact or harm. No impact or harm to invertebrates, fish, EFH, or sea turtles is expected from aircraft noise, as there is a lack of sufficient sound transmission across the air/water interface to a depth where invertebrates, fish, EFH, sea turtles are expected and there is no overlap between aircraft activities and sea turtles. The potential impact or harm of aircraft noise to seabirds, and marine mammals is provided in detail below.

4.1.5.1.a In Air

Most of the acoustic energy transmitted into the water from an aircraft arrives through a relatively narrow cone extending vertically downward from the aircraft (Figure 4-1) (Eller and Cavanagh 2000; Richardson et al. 1995). The intersection of this cone with the surface traces a "footprint" directly beneath the flight path, with the width of the footprint being a function of aircraft altitude. Furthermore, in air noise decreases with distance, with a decrease in sound level from any single noise source following the "inverse-square law." In other words, the SPL changes in inverse proportion to the square of the distance from the sound source. Therefore, aircraft sound levels actually at the air-water interface (i.e., sea surface) is a function of how high above the surface the aircraft is flying or hovering. Thus, the higher the aircraft, the less sound reaches the sea surface (Eller and Cavanagh 2000; Richardson et al. 1995). Any sound produced by the UAV is expected to be less than that produced by the helicopter.

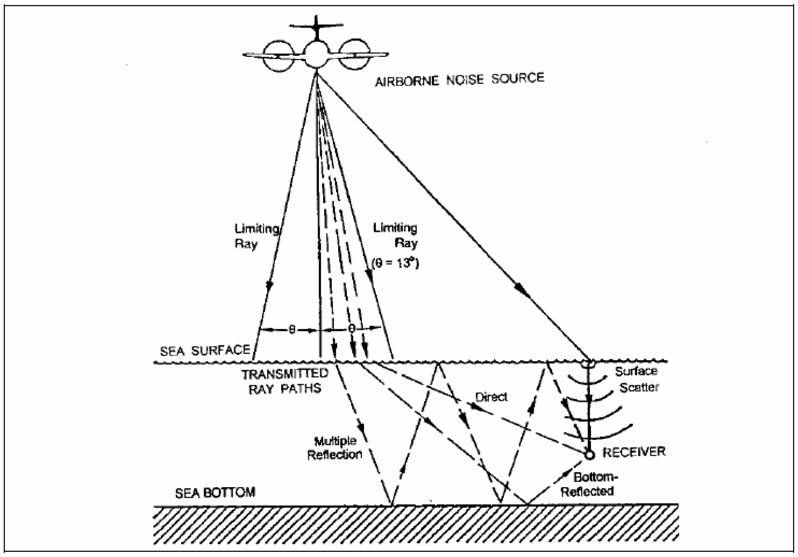

Figure 4-1. Characteristics of Sound Transmission through the Air-Water Interface (Richardson et al. 1995)

4.1.5.1.b Sea Surface (Air-Water Interface)

As stated above, aircraft sound levels present at the air-water interface (i.e., sea surface) is a function of how high above the surface the aircraft is flying or hovering. Thus, the higher the aircraft, the less sound reaches the sea surface.

Given in air transmission loss with distance via the previous discussion of the inverse-square law, it would be estimated that a 136 dB re 20 µPa helicopter source level at 100 ft (30.5 m) would measure an SPL of approximately 106 dB re 20 µPa at the air-water interface (i.e., sea surface), while the same source level at 10 ft (3 m) would measure an SPL of approximately 126 dB re 20 µPa at the air-water interface. Aircraft associated with the Proposed Action would not operate at altitudes under 1,500 ft (457 m). Therefore, the received level estimated above would be significantly less than 106 dB re 20 µPa when measured at the surface if the helicopter were at an altitude of 1,500 ft (457 m). Any sound produced by the UAV is expected to be less than that produced by the helicopter.

For the reasons described (see footnote[2]), the sound values in air and in water are not directly comparable due to the reference units used, and must be converted[11]. The result is that sound waves with the same intensities in water and air have relative intensities that differ by 26 dB. This amount

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[11] Sound in water and sound in air are both waves that move similarly and can be characterized the same way. However, even though sound waves in water and sound waves in air are basically similar, the way that sound levels in water and sound levels in air are reported is very different, and comparing sound levels in water and air must be done carefully. Confusion arises because sound levels given in dB in water are not the same as sound levels given in dB in air. There are two reasons for this:

1) Reference intensities. The reference intensities used to compute sound levels in dB are different in water and air. Scientists have arbitrarily agreed to use as the reference intensity for underwater sound the intensity of a sound wave with a pressure of 1 microPascal (µPa). Scientists have agreed to use as the reference intensity for sound in air the intensity of a sound wave with a pressure of 20 µPa. This value in air is because it is consistent with the minimum threshold of young human adults in their range of best hearing (1000 -3000 Hz). 2) Densities and sound speeds. Intensity of a sound wave depends not only on the pressure of the wave, but also on the density and sound speed of the medium through which the sound is traveling. Sounds in water and sounds in air that have the same pressures have very different intensities because the density of water is much greater than the density of air and because the speed of sound in water is much greater than the speed of sound in air. For the same pressure, higher density and higher sound speed both give a lower intensity.

(26 dB) must be added to sound levels in air referenced to 20 µPa to obtain the sound level in water referenced to 1 µPa. In consideration of the air-water interface, another 6 dB would have to be added (doubling of pressure across interface), such that 26 dB + 6dB or 32 dB would have to be added to any in air value to estimate its corresponding in water transition value (ex. 100 dB re 20 µPa in air + 26 dB +6 dB= 132 dB re 1 µPa in water). Therefore, for a helicopter at 100 ft (30.5 m), the in water sound just beneath the surface would be approximately 138 dB re 1 µPa. For a helicopter at 10 ft (3 m), the in water sound just beneath the surface would be approximately 168 dB re 1 µPa.

4.1.5.1.c In Water

Helicopter overflights produce airborne noise and some of this energy is transmitted into the water. Transmission of sound from a moving airborne source to a receptor underwater is influenced by numerous factors and has been addressed by Urick (1983), Young (1973), Richardson et al. (1995), and Eller and Cavanagh (2000). Sound is transmitted from an airborne source to a receptor underwater by four principal means: (1) a direct path, refracted upon passing through the air-water interface; (2) direct-refracted paths reflected from the bottom in shallow water; (3) evanescent transmission in which sound travels laterally close to the water surface; and (4) scattering from interface roughness due to wave motion.

Aircraft sound is refracted upon transmission into water because sound waves move faster through water than through air (a ratio of about 0.23:1). Based on this difference, the direct sound path is reflected if the sound reaches the surface at an angle more than 13° from vertical. As a result, most of the acoustic energy transmitted into the water from an aircraft arrives through a relatively narrow cone extending vertically downward from the aircraft.

Traveling beyond the sea surface, the sound values in air and in water are not directly comparable due to the reference units used, and must be converted. The result is that sound waves with the same intensities in water and air have relative intensities that differ by 26 dB. This amount (26 dB) must be added to sound levels in air referenced to 20 µPa to obtain the sound level in water referenced to 1 µPa. In consideration of the air-water interface, another 6 dB would have to be added (doubling of pressure across interface), such that 26 dB + 6dB or 32 dB would have to be added to any in air value to estimate its corresponding in water transition value (ex., 100 dB re 20 µPa in air + 26 dB +6 dB= 132 dB re 1 µPa in water).

Any sound that does enter the water from a passing aircraft or hovering helicopter is refracted due to the difference in sound velocity between air and water as mentioned previously. Sound is transmitted from an airborne source to a receptor underwater, such as a marine mammal by: (1) direct path, refracted upon passing through the air-water interface; and, (2) direct-refracted paths reflected from the bottom in shallow water.

Therefore, for a helicopter at an altitude of 100 feet, the in water sound just beneath the surface would be approximately 138 dB re 1 µPa. For a helicopter at 10 ft (30.5 m), the in water sound just beneath the sea surface would be approximately 168 dB re 1 µPa. Helicopter sounds that do enter the water would be subject to further transmission loss with distance. The underwater noise produced is generally brief when compared with the duration of audibility in the air. Due to the relatively small area over which aircraft noise would radiate outward, the noise in water would be transient. Any sound produced by the UAV is expected to be less than that produced by the helicopter and, similar to helicopters, would also be transient.

4.1.5.1.d Under Ice

The inhomogeneous nature of sea ice does not necessarily allow for attenuation of noise from the air through an ice layer and into the water. When aircraft noise passes from air to water, there is a limiting ray of 13°, where the noise will be reflected off the surface of the water instead of passing through (Richardson et al. 1995). At frequencies less than 500 Hz, the ice layer is acoustically thin and causes little attenuation of sound (Richardson et al. 1991). This implies that noise travelling through sea ice would only be slightly lower than that same noise travelling directly from the air to the water. It is expected that transmission of low-frequency sound through ice would be only slightly lower than that of low-transmission sound travelling directly from the air into the water (Richardson et al. 1995). Use of the air-water transmission model would provide slight overestimates of underwater sound levels from aircraft overflights, but this is the best model currently available to analyze airborne sound transmission through ice (Richardson et al. 1995).

If ice is present beneath aircraft operations, noise levels would be lowered by the time helicopter noise reached the surface of the ice from an overhead flight. Any sound produced by the UAV is expected to be less than that produced by the helicopter. The thickness of the ice would also influence the extent of transmission as helicopter sound would have to attenuate through the ice. Therefore, based on the above information, it is expected that if any resulting underwater noise did penetrate through the ice, it would be brief.

4.1.5.2 Seabirds and Shorebirds

The potential impact or harm to seabirds from aircraft noise is from auditory fatigue, TTS, PTS, or behavioral response. In air, birds hear best in air between 1 and 3 kHz (Crowell et al. 2015). The dominant tones in noise spectra from helicopters and fixed wing aircraft are typically below 500 Hz (Richardson et al. 1995). A bird may experience PTS if exposed to a continuous SPL over 110 dBA re 20 µPa in air (Dooling and Therrien 2012), but this is not expected, so PTS would not occur as a result of aircraft noise associated with the Proposed Action.

In air, seabirds would have to be flying within the cone of noise beneath a helicopter to detect any noise. Average seabird flight altitudes range from 33–130 ft (10–40 m), depending on the species, with most species flying at the lower end of this range (Cook et al. 2012; Day et al. 2005; Krijgsveld et al. 2005). In their study of flight speeds across all major seabird taxa (98 species total), Spear and Ainley (Spear and Ainley 1997) recorded average ground speeds of between 10.7 and 43.3 knots. The typical flight speeds of ESA-listed species range from 22 knots, the average speed of albatross species (Alerstam et al. 1993), to the much faster eiders, flying at speeds of roughly 42 knots (Day et al. 2005), and the marbled murrelet, flying at speeds of more than 55 knots (Harper et al. 2004). In air, despite these flight speeds, and regardless of aircraft speeds, noise exposure is possible, though limited because seabirds would have to be within the downward-directed cone of helicopter noise in order to detect it.

Helicopters would not hover for prolonged periods over one area. If helicopters needed to fly over birds, they would do so at an altitude of 1,000 ft (305 m) or more, so any disruption of normal behavior would be brief. Seabirds generally remain well below the typical helicopter flight altitudes associated with the Proposed Action. Higher-altitude migrations by waterfowl and shorebirds occur over parts of the Arctic and Pacific Northwest proposed action areas, but these altitudes are on the order of 0.62 mi (1 km) (Alerstam et al. 2007; Alerstam and Gudmundsson 1999a; Alerstam and Gudmundsson 1999b; Gudmundsson et al. 2002), which is well below the typical helicopter flight altitudes associated with the

Proposed Action. Takeoffs and landings, which pass through lower altitudes, would be infrequent relative to other aerial operations associated with the Proposed Action, and would occur at FOLs or on the icebreaker.

Continuous noise exposure at levels above 90– 95dB(A) re 20 µPa can cause TTS (Dooling and Therrien 2012). However, the use of a helicopter in the Proposed Action would only be expected to temporarily increase overall noise, as any increase would only be for short periods and geographically limited to the helicopter as it travels along its route. The likelihood that a seabird would travel along the same route as the helicopter for a long enough period to receive continuous exposure to helicopter noise is extremely low. In addition, it is extremely unlikely that a seabird would remain in the narrow cone of noise beneath the helicopter. Thus, no TTS to seabirds is expected as part of the Proposed Action.

As noted above, aircraft sound is refracted upon transmission into water and, based on this difference, the direct sound path is reflected if the sound reaches the surface at an angle more than 13° from vertical. As a result, most of the acoustic energy transmitted into the water from an aircraft arrives through a relatively narrow cone extending vertically downward from the aircraft. As only a narrow cone of noise beneath a helicopter would lead to helicopter sound entering the water, sound levels within that cone would be at relatively low levels at the air-sea interface, and would quickly attenuate with distance underwater or away from the cone. Beyond the narrow cone, sound would be expected to either be absorbed by the surface it comes in contact with or refracted off the surface and dissipate. Underwater, an MH-60 helicopter flying at 50 ft (15 m) produces an in-water maximum received level of 125 dB re 1 µPa at a depth of 3.3 ft (1 m) (Richardson et al. 1995). However, diving birds do not spend prolonged periods of time underwater (Hawkins et al. 2000; Heath et al. 2007) and helicopters associated with the Proposed Action would be above this altitude. Thus, it is unlikely birds would suffer auditory fatigue, TTS, or PTS due to prolonged proximity to helicopter noise.

Noise from helicopters may elicit short-term behavioral or physiological responses in exposed birds, such as an alert or startle response, or temporary increases in heart rate. A behavioral response may include the disruption of feeding of birds at or near the water’s surface, or a behavioral disturbance of birds in flight, on land, or on ice. However, in a Swiss study of the reactions of water birds to overflights, birds returned to normal behavior within five minutes of each flight passing overhead (Komenda-Zehnder et al. 2003). Therefore, overflights of aircraft are not expected to cause more than short-term behavioral responses in ESA-listed seabirds.

Coast Guard would avoid large gatherings of seabirds, both for the safety of personnel and flight operations and for the protection of these animals and would follow the SOPs and BMPs (see Chapter 6). Therefore, any behavioral reactions by birds, should there be any, would be limited to a small number of individuals. Repeated exposure of individual seabirds or groups of seabirds is also unlikely, based on the above avoidance measures and dispersed and irregular nature of the overflights. Thus, the general health of individual seabirds would not be compromised, and disruptions to major behavior patterns (such as migration) would not be expected.

Flight paths in the Arctic and Antarctic proposed action areas are planned to avoid critical habitat areas and areas where there are known gatherings of seabirds. While flights would concentrate departures from established FOLs in the Arctic proposed action area, flight paths would be dispersed widely throughout the area in order to land on the transient PIB wherever it is located. Flights in the Antarctic would not be as dispersed as those in the Arctic proposed action area, but flights would avoid any known aggregations of seabirds, such as penguin colonies. The long-term effect of Proposed Action’s activities on ESA-listed seabirds is expected to be negligible because any response is expected to be temporary and any seabird that did exhibit a behavioral response would be expected to return to its normal behavior once the stimulus is gone. Aircraft noise associated with the Proposed Action would not alter the physical or biological features essential to the conservation of ESA-listed seabird species. Seabirds are either not likely to respond to aircraft noise or are not likely to respond in ways that would significantly disrupt normal behavior patterns which include, but are not limited to: migration, breeding, feeding, or sheltering.

Aircraft noise associated with the Proposed Action would not result in significant impacts to birds or result in significant harm to birds. Pursuant to the ESA, aircraft noise associated with the Proposed Action may affect, but is not likely to adversely affect the ESA-listed marbled murrelet, short-tailed albatross, Steller's eider, and spectacled eider. The Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat of the spectacled or Steller's eider. There would be no effect to federally-designated marbled murrelet critical habitat as it is located outside of the Pacific Northwest proposed action area. Pursuant to the MBTA, aircraft noise associated with the Proposed Action would not result in a significant adverse effect on migratory bird populations.

4.1.5.3 Marine Mammals

Potential impact or harm to marine mammals from aircraft could involve both acoustic and non-acoustic effects and it is uncertain if reactions are due to the sound or physical presence of the aircraft flying overhead. Aircraft noise would include noise generated by the MH-60 Jayhawk helicopter during flights associated with the Proposed Action and from the UAVs used for ice reconnaissance. Behavioral responses by marine mammals could include quick dives or turns, change in course, or flushing and stampeding from a haulout site. There are few well-documented studies of the impact or harm of aircraft overflight over pinniped haulout sites or rookeries, and many of those that exist are specific to military activities (Efroymson et al. 2001). There are even fewer documented studies of the impact or harm of aircraft overflights to marine mammals at the water's surface. Potential impact or harm to marine mammals from aircraft noise may occur due to auditory fatigue, TTS, PTS, or behavioral reactions.

4.1.5.3.a Cetaceans

The reactions of cetaceans to aircraft noise are varied and often dependent on what the animal is doing at the time (e.g., migrating, feeding, mating, etc.). In general, a behavioral response by cetaceans could include a decrease in swim speed, change in direction of travel, or a cessation of feeding or mating in response to broadcast sounds. Cetaceans may exhibit various behavioral reactions to aircraft overflights such as diving underwater, slapping the water's surface with their flukes or flippers, or swimming away from the aircraft track (Richardson et al. 1995).

The reactions of mysticetes to aircraft noise are varied and often dependent on what the animal is doing at the time (e.g., migrating, feeding, mating, etc.). In general, a behavioral response by mysticetes could include a decrease in swim speed, change in direction of travel, or a cessation of feeding or mating in response to broadcast sounds. Mysticetes may exhibit various behavioral reactions to aircraft overflights such as diving underwater, slapping the water's surface with their flukes or flippers, or swimming away from the aircraft track (Richardson et al. 1995). For example, bowhead whales react to overflight aircrafts in various ways as well such as diving underwater, turning away from the aircraft, and dispersing away from the area exposed to the aircraft. Bowhead whales frequently reacted to a circling piston-engine aircraft at less than 1,000 ft (305 m) in altitude. Infrequent reactions occurred at 1,499 ft (457 m) of altitude and rare reactions occurred at greater than 2,001 ft (610 m) (Richardson et al. 1995). Reactions seem more pronounced when bowhead whales are in shallow water. Repeated overflights did not seem to displace many (if any) bowheads from feeding areas. (Watkins and Moore 1983) found that, when below 492 ft (150 m) in altitude, some disturbance to right whales may occur. Payne et al. (1983) saw rare reactions to a circling aircraft between 16 and 492 ft (5 and 150 m) in altitude. Bowhead whales appear to be more susceptible to aircraft overflights while resting and less so when actively feeding, mating, or socializing. Patenaude et al. (2002) observed 63 bowhead whale groups and 40 groups of beluga whales. Fourteen percent of bowhead whales and 38 percent of beluga whales responded to the sound of a Bell 212 helicopter passing overhead repeatedly at an altitude of 492 ft (150 m) and a distance of 820 ft (250 m). Responses included short surfacings, immediate dives or turns, vigorous swimming, and breaching. Meanwhile, gray whale reactions to aircraft are variable and mothers with calves seem to be particularly sensitive (Clarke et al. 1989; Ljungblad and Moore 1983). Malme et al. (1983; 1984) observed the behavioral reactions of gray whales from underwater playbacks of a Bell 212 helicopter and noted that there were changes to their swim speed and direction of travel.

Belugas may swim away, dive abruptly, look upwards, or turn sharply away from low-altitude overflights (Richardson et al. 1995). They have also been recorded to have no visual behavioral reaction to aircraft flights within 100 to 200 m (Richardson et al. 1995). Clarke (1956) observed that some sperm whales showed no reaction to a helicopter at a low altitude unless they were in its downwash. At an altitude of 492–755 ft (150–230 m), some sperm whales remained at the surface while others dove immediately (Mullin et al. 1991). Any noise generated by the UAV is expected to be minimal and below the hearing threshold of marine mammals, both in-air and under-water (where noise would attenuate even further). Therefore, as described above, behavioral reactions of cetaceans to aircraft noise associated with the Proposed Action are expected to be, at most, minor to moderate avoidance responses of a few individuals, over short and intermittent periods.

4.1.5.3.b Pinnipeds and Polar Bears

Pinnipeds, otariids, and polar bears, more so than cetaceans, have the potential to be disturbed by airborne and underwater noise generated by the engine of the aircraft (Born et al. 1999; Richardson et al. 1995) because they spend part of their life on land and not exclusively in the water. In 2004, researchers measured auditory fatigue to airborne sound in harbor seals, California sea lions, and northern elephant seals after exposure to non-pulse noise for 25 minutes (Holt et al. 2004; Kastak et al. 2004; Kastak et al. 2005). In the study, the harbor seal experienced approximately 6 dB of TTS at 99 dB re 20 μPa. The authors identified onset of TTS in the California sea lion at 122 dB re 20 μPa. The northern elephant seal experienced TTS-onset at 121 dB re 20 μPa (Kastak et al. 2004). There is a dearth of information on acoustic effects of helicopter overflights on pinniped hearing and communication (Richardson et al. 1995) and to the Coast Guard’s knowledge, there has been no specific documentation of TTS or PTS in free-ranging pinnipeds exposed to helicopter operations during realistic field conditions. Therefore, as described above, physical effects to pinnipeds from aircraft noise associated with the Proposed Action are not expected. While noise from aircraft would not be expected to cause direct physical effects, aircraft noise has the potential to affect behavior.

Behavioral reactions of hauled out pinnipeds to aircraft flying overhead have been noted, such as looking up at the aircraft, moving on the ice or land, entering a breathing hole or crack in the ice, or entering the water (Blackwell et al. 2004; Born et al. 1999). Reactions depend on several factors including the animal’s behavioral state, activity, group size, habitat, age or experience, and the flight pattern of the aircraft (Richardson et al. 1995). Walruses, for example, have very varied reactions to aircraft overflights from looking upward to diving underwater (Richardson et al. 1995). Spotted seals haul out on sea ice react at considerable distances to aircraft by moving swiftly across ice floes and diving off into the water (Richardson et al. 1995). Spotted seals on beaches move into the water when a survey aircraft flies over at altitudes up to 1,000 to 2,493 ft (305 to 760 m) or more and at lateral distances up to 0.6 mi (1 km). This fleeing behavior persists despite frequent exposure to aircraft overflights, but the seals return to their haulout sites shortly after exposure (Richardson et al. 1995).

Reactions to helicopter disturbance are difficult to predict, though helicopters have been recorded to elicit a stronger behavioral response (e.g., diving, increase in surfacing) by bearded and ringed seals (Born et al. 1999). Observations of ringed seals within the water column showed some ringed seals surfaced 66–98 ft (20–30 m) from the edge of an ice pan only a few minutes after a helicopter had landed and shut down near the ice edge (Richardson et al. 1995). Additionally, a study conducted by Born et al. (1999) found that wind chill was also a factor in level of response of ringed seals hauled out on ice (higher wind chill increases probability of leaving the ice), as well as time of day and relative wind direction. Overall, there has been no indication that single or occasional aircraft flying above pinnipeds in water cause long term displacement of these animals (Richardson et al. 1995). The Lowest Observed Adverse Effects Levels are rather variable for pinnipeds on land, ranging from just over 492 ft (150 m) to about 6,563 ft (2,000 m) (Efroymson et al. 2001). A conservative (90th percentile) distance effects level is 3,773 ft (1,150 m). Most thresholds represent movement away from the overflight. (Bowles and Stewart 1980) estimated a Lowest Observed Adverse Effects Level of 1,000 ft (305 m) for helicopters (low and landing) in California sea lions and harbor seals observed on San Miguel Island, California; animals responded to some degree by moving within the haulout and entering into the water, stampeding into the water, or clearing the haulout completely. Both species always responded with the raising of their heads. California sea lions appeared to react more to the visual cue of the helicopter than the noise. Coast Guard aircraft would maintain an altitude of 1,500 ft (457 m) (see Chapter 6). Aircraft would also stay at or above 3,000 ft (914 m) within a biologically sensitive area in order to avoid disturbance.

As a case for reference, in 2008, NMFS issued an Authorization to the USFWS for the take of small numbers of Steller sea lions and Pacific harbor seals, incidental to rodent eradication activities on an islet offshore of Rat Island, Alaska (USFWS 2009b). This rodent eradication would be conducted by helicopter; the 15-minute aerial treatment consisted of the helicopter slowly approaching the islet at an elevation of over 1,000 ft (304.8 m), gradually decreasing altitude in slow circles, and applying the rodenticide in a single pass then returning to Rat Island. The gradual and deliberate approach to the islet resulted in the sea lions present, initially becoming aware of the helicopter and then calmly moving into the water. Further, the USFWS reported that all responses fell well within the range of Level B harassment, as defined under the MMPA, (i.e., limited, short-term displacement resulting from aircraft noise due to helicopter overflights) (USFWS 2009b).

As a general statement from the available information, pinnipeds exposed to intense (approximately 110 to 120 dB re 20 μPa) non-pulse sounds often leave haulout areas and seek refuge temporarily (minutes to a few hours) in the water (Southall et al. 2007). Per Richardson et al. (1995), approaching aircraft generally flush animals into the water and noise from a helicopter is typically directed down in a ‘‘cone’’ underneath the aircraft. In these cases, the helicopter was deliberately approaching areas where pinnipeds were expected. The Coast Guard would not deliberately approach known areas where pinnipeds are expected; therefore, any impact or harm to pinnipeds as a result of proposed action activities is expected to be considerably less than the above mentioned case studies.

Behavioral reactions of ringed seals to aircraft have been recorded. Ringed seal pups are born in lairs from mid-March through April, and mothers nurse their pups in the lairs for five to eight weeks (Hammill et al. 1991; Lydersen and Hammill 1993; Smith et al. 1973). Sea ice habitat that is suitable for the formation and maintenance of subnivean birth lairs (used for sheltering pups during whelping and nursing), is typically seasonal landfast (shorefast) ice, except for any bottom-fast ice extending seaward from the coast line in waters less than 6.6 ft (2 m) deep, or dense, stable pack ice that has undergone deformation and contains snowdrifts at least 21 in (54 cm) deep. From mid-May through early June, ringed seals also frequently haul out on the exposed ice surface. Ringed seals were shown to leave their subnivean lairs and enter the water when a helicopter was at an altitude of less than 1,000 ft (305 m) and within 1.2 mi (2 km) lateral distance (Richardson et al. 1995). Ringed seal vocalizations in water were similar between areas subject to low-flying aircraft and areas that were less disturbed (Calvert and Stirling 1985). These data suggest that although a ringed seal may leave a subnivean lair (Burns et al. 1982), aircraft disturbance was temporary and did not cause the animals to leave the general area. Williams et al. (2006) investigated whether ringed seals use of breathing holes and lairs during winter and spring was affected by the construction and drilling on Northstar Island, built in the nearshore Alaskan Beaufort Sea, and determined that activities did not negatively affect the seals' use of their lairs. Williams et al. (2006) further determined that given the turnover and creation of new structures (lairs) during the ice-covered season, it was unlikely that the loss of a breathing hole or resting structure over the course of the winter, from natural or anthropogenic causes, would significantly impact an individual seal. Structures used by ringed seals are not distributed randomly and are usually concentrated along pressure ridges, cracks, leads, or other surface deformations (Furgal et al. 1996; Hammill and Smith 1989; Lydersen and Smith 1989; Nichols 1999; Smith and Stirling 1975). It is expected that should the Coast Guard land on the ice with a helicopter during personnel transport, these landings would be considered rare and would not occur in the same location (e.g., consecutive repetitive landings in the same spot on the ice). Thus, impacts from landing a helicopter on the ice would be short-term. Although lairs are often cryptic and likely difficult to identify from air, they are rarely occupied for long periods and as mentioned previously, ringed seals tend to use structures for shorter periods in areas of higher ice deformation. In all likelihood, most of the personnel transport to any ice location would occur outside of the pupping season, so impacts to ringed seals associated with lairs would be extremely low. In addition, the Coast Guard would follow SOPs and BMPs (see Chapter 6) to avoid impacts to hauled out pinnipeds. Therefore, the Coast Guard does not anticipate any effect from aircraft activities to ringed seals in subnivean lairs during the Proposed Action.

While much is still unknown about polar bear social structure, most encounters with polar bears would be with individual males, juveniles alone or in pairs, or females alone or with one to two cubs. Behavioral reactions of a species or individuals depends on several factors including, but not limited to: the animal's current behavioral state at the time of exposure, activity, group size, habitat, age or experience, and the flight pattern of the aircraft (Richardson et al. 1995). Behavioral responses by polar bears could include quick movements, a change in course or speed, or running or swimming away, depending on whether the bear is on land or ice or in water.

Polar bears have been seen moving away from helicopters at an altitude of less than 656 ft (200 m) or at a distance of less than 1312 ft (400 m) (Richardson et al. 1995). An aircraft approaching close to a polar bear den does not usually cause the polar bear to abandon the den since snow greatly attenuates aircraft noise (Amstrup 1993). It is unlikely that an individual would be exposed repeatedly for long periods due to the short duration of the aircraft flights during the Proposed Action, considering the vast size of the polar bear home range. The likelihood that a polar bear would travel along the same route as the helicopter for a long enough period to receive continuous exposure to helicopter noise is extremely low. The likelihood of a polar bear being under the flight path for multiple flights or for a long duration of one flight would be low. Thus, noise from aircraft would not be expected to cause direct physical effects, but aircraft noise does have the potential to temporarily affect behavior.

In 2010, the USFWS has released “polar bear interaction” guidelines (75 FR 61631; October 6, 2010) to ensure that activities are conducted in a manner that avoids conflicts between humans and polar bears. This guidance suggests keeping overflights to an altitude of at least 2,000 ft (610 m) vertically and 0.5 mi (0.8 km) horizontally in order to avoid disturbing bears with aircraft. The flights for the MH-60 Jayhawk helicopter and UAVs in the Proposed Action maintain overflights above 1,000 ft (305 m). Aircraft would also stay at or above 3,000 ft (914 m) within an environmentally sensitive area in order to avoid disturbances. At these altitudes, no behavioral response from polar bears is expected.

Coast Guard aircraft would support the recovery of protected living marine resources through internal compliance with laws designed to preserve marine protected species, including planning passage around marine sanctuaries, such as federally-designated critical habitat. These actions would minimize the impact or harm of aircraft noise to marine mammals and federally designated critical habitat. The Coast Guard would post lookouts and train crew members so that when a marine mammal is sighted, the bridge or pilot would be alerted, so avoidance measures can be taken. Coast Guard would avoid any close approaches by aircraft of marine mammals in the water or any known haulout areas that may be within the proposed action areas and would follow SOPs and BMPs in Chapter 6.

Weather conditions are often a factor in the proposed action areas and therefore, an unexpected situation could occur where a helicopter needs to divert from its planned route or the helicopter needs to fly lower than originally anticipated. The Coast Guard would continue to post lookouts to sight marine mammals, although sighting conditions may be compromised due to the weather conditions and could alter a lookouts’ ability to detect marine mammals. As long as navigational safety is not compromised, Coast Guard would follow SOPs and BMPs to avoid marine mammals. If an unexpected situation with regard to flight patterns and weather occurs, and in the unlikely event that pinnipeds are hauled out in area that is not a known haulout site or rookery that is actively being avoided, it is possible that a low-flying helicopter could cause some disturbance to an unknown number of pinnipeds. While the number of pinnipeds would be unknown, it is assumed that the total number would be considerably less than what would be expected at a known rookery or haulout site. The initial helicopter approach to these hauled out animals could cause a subset, or all of the marine mammals hauled out, to depart and move into the water. Thus, some animals may be temporarily displaced from the haulout and either raft in the water, relocate to other haulouts, or immediately return to the haulout where they were just displaced. The likelihood of the temporary presence of Coast Guard assets in one area due to unplanned events caused by weather is extremely rare. Therefore, the long-term effect of Proposed Action’s activities on hauled out animals is expected to be negligible because any response is expected to be temporary and any animal that did exhibit a behavioral response would be expected to return to its normal behavior once the stimulus is gone. There would be no impact or harm to breeding, feeding, migrating, or sheltering and thus, to the health and fitness of that individual(s).

Since aircraft noise, specifically the noise generated by the helicopter operations, may cause behavioral responses (e.g., a marine mammal temporarily avoiding an area) the Coast Guard would request authorization under the MMPA from NMFS and the USFWS for Level B take of marine mammals in accordance with MMPA. Aircraft noise from the Proposed Action is not likely to significantly impact marine mammals or result in significant harm to marine mammals. Any noise generated by the UAV is expected to be minimal and below the hearing threshold of marine mammals, both in-air and underwater (where noise would attenuate even further). Pursuant to the ESA, aircraft noise would have no effect on leatherback sea turtles and Southern Resident killer whales as aircraft operations would not occur in the Pacific Northwest proposed action area. Pursuant to the ESA, aircraft noise may affect, but is not likely to adversely affect the ESA-listed blue whale, bowhead whale, fin whale, gray whale, humpback whale, North Pacific right whale, polar bear, sei whale, sperm whale, bearded seal, ringed seal, and the Steller sea lion.

Although, aircraft noise would have a greater potential to impact airspace, and areas over land or ice, MH-60 Jayhawk helicopters and UAVs would maintain overflights above 1,000 ft (305 m). The Coast Guard would avoid any designated critical habitat areas, but should aircraft require overflights over critical habitat, aircraft would stay at or above 3,000 ft (914 m) over any environmentally sensitive area in order to avoid potential disturbance. In addition, at these altitudes, aircraft noise would attenuate in critical habitat features that include sea ice dens and lairs, and the water column. The attenuation would also decrease potential marine mammal detection of aircraft noise, thereby minimizing any marine mammal behavioral response. Aircraft noise would not alter any resources essential to the conservation of ESA-listed marine mammals. The Proposed Action would not result in the destruction or adverse modification of federally-designed critical habitat for the North Pacific right whale, polar bear, Southern Resident killer whale, Steller sea lion, or the proposed ringed seal critical habitat.

4.1.5.4 Impacts from Aircraft Noise Under the Alternatives 2 and 3

Alternative 2: Leasing

It is assumed that aircraft would be used in support of a leased vessel, thus, aircraft noise from a leased vessel would be similar to what is in current use and the potential impact would be similar to what was analyzed under Alternative 1. Therefore, the potential impacts associated with aircraft noise under Alternative 2 are the same as under Alternative 1. Therefore, aircraft noise from Alternative 2 is not likely to significantly impact or result in significant harm to birds, and marine mammals.

Alternative 3: No Action

Under the No Action Alternative, the Coast Guard would fulfill its missions in the Arctic and Antarctic using existing polar icebreaker assets, which are reaching the end of their service lives. The current polar icebreaker fleet would continue current operations. Therefore, as long as the current polar icebreaker fleet is operational and includes air support, baseline conditions of the existing environment would remain unchanged and would not significantly impact or result in significant harm to birds and marine mammals. Once the current fleet of icebreakers are decommissioned and no longer in operation, the Coast Guard would no longer have polar icebreakers in their fleet and therefore, operations and training from a polar icebreaker would no longer occur.

4.1.6 Gunnery Noise

Defensive and offensive gunnery training aboard the PIB would fire inert (i.e., non-explosive) small caliber (0.50 caliber or MK-38 standard [25 mm]) gun rounds. Noise associated with weapons firing and the impact of non-explosive practice munitions would occur either within the Pacific Northwest proposed action area at locations greater than 12 nm from shore, or within an existing Navy firing range. The firing of a weapon may have several components of associated noise. Firing of guns could include sound generated by firing the gun (muzzle blast), vibration from the blast propagating through a ship's hull, and sonic booms generated by the projectile flying through the air. In addition, the impact of non-explosive practice munitions at the water surface can introduce sound into the water.

The approximate peak amplitude produced by firing a 50 caliber round is 151 dB re 20 μPa at a distance of 10 ft (3 m) (Luz 1983). This amplitude dissipates to 139 dB at 50 ft (15 m) and to 127 dB at 150 ft (45 m) (Luz 1983). A MK-38 round (25 mm) would be anticipated to be roughly 18 dB louder at the same distances (Luz 1983; Ylikoski et al. 1995). Ylikoski et al. (1995) characterized the sound profile from a small caliber (7.62 mm NATO) weapon firing as ranging from 150–2,500 Hz (with a peak from 900–1,500 Hz). The rounds fired as part of the Proposed Action are slightly larger than this, but similar frequency ranges could be expected.

Sound level intensity decreases with increased distance from the firing location and increased angle from the line of fire (Pater and Shea 1981). Multiple, rapid gun firings would occur from a single firing point toward a target area. Vessels participating in gunfire activities would maintain enough forward motion to maintain steerage, normally at speeds of a few knots. Acoustic impacts from weapons firing would often be concentrated in space and duration.

Firing a ship deck gun produces a muzzle blast in air that propagates away from the muzzle in all directions, including toward the water surface. Most sound enters the water in a narrow cone beneath the sound source (within 13° of vertical). The energy transmitted through the ship to the water for a typical round was about 6 percent of that from the air blast impinging on the water. Therefore, sound transmitted from the gun through the hull into the water is a minimal component of overall weapons firing noise.

No impact or harm to invertebrates, fish, EFH, sea turtles, and marine mammals, is expected from gunnery noise as gunnery noise attenuates substantially underwater; therefore, gunnery noise is not expected to impact or harm species while underwater, as the in-air noise would not propagate through the air-water interface. Additionally, gunnery noise is outside the range of best hearing for fish and sea turtles. Gunnery training would not occur in a location where pinnipeds are hauled out. No impact or harm to Arctic or Antarctic species is expected from gunnery noise as these activities will take place only in the Pacific Northwest proposed action area. The potential impact or harm of gunnery noise to seabirds (from the in-air transmission of gunnery noise) found in the Pacific Northwest proposed action area is provided in detail below.

4.1.6.1 Seabirds and Shorebirds

Seabird hearing ranges from 1–3 kHz, so the noise from gunnery training may be detected by seabirds. In addition to noise from weapons firing and launching, seabirds could be briefly disturbed by the impact of non-explosive practice munitions at the water's surface. Sounds produced by weapons firing (muzzle blast), launch boosters, and projectile travel are potential stressors to birds. Sound generated by a muzzle blast is intense, but very brief.

Because most weapons firing activities occur far from shore, seabirds that forage or migrate greater than 3 nm offshore are most likely to hear and respond to weapons firing noise. Seabirds that are attracted to ships are more likely to be exposed to weapons firing noise. The species of seabirds that commonly follow vessels include certain species of gulls, storm petrels, and albatross (Hamilton 1958; Hyrenbach 2001; Hyrenbach et al. 2006). However, other activities in the general area that precede weapons firing activities, such as vessel movement or target setting, would potentially disperse seabirds away from the area in which weapons firing noise would be detected. Once surface weapons firing activities begin, seabirds would likely disperse away from the area around the vessel and the path of projectiles. The ESA-listed marbled murrelet does not follow vessels and it is rarely found more than 1.2 mi (2 km) off shore in the waters of the Pacific Northwest proposed action area. Because marbled murrelets are rarely located beyond 1.2 mi (2 km) from shore, they are not expected in areas in which gunnery training would occur.

Seabird responses to weapons firing and projectile travel noise may include short-term behavioral or physiological responses such as alert responses, startle responses, or temporary increases in heart rate. Exposure of seabirds to weapons firing and impact noise would be very brief and temporary. While an individual seabird may be exposed to multiple noises during a weapons firing activity, repeated exposures to individual seabirds over many days is extremely unlikely. Both seabirds and vessels would be expected to change location frequently, and weapons firing and launch activities would occur over short periods of time. The total time for weapons firing during gunner training is approximately 30 minutes during each training. Startle or alert reactions to muzzle blasts are not likely to disrupt major behavior patterns, such as migrating, breeding, feeding, and sheltering, or to result in serious injury to any seabirds. Activities with multiple weapons blasts may cause seabirds to disperse from the area for the duration of the firing activity. Because weapons firing activities would not occur close to shore where seabird colonies are located, large impacts on breeding seabird populations would not result from weapons firing noise. For these reasons, the impact on seabirds from noise produced by weapons firing would be minor and temporary and would not have any population level impacts. Because weapon firing occurs at varying locations over a short time period and seabird presence changes seasonally and on a short-term basis, individual seabirds would not be expected to be repeatedly exposed to weapons firing or projectile noise. Although unlikely, any impacts to migratory or breeding seabirds related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent and would not impact seabird or migratory bird populations.

Gunnery noise associated with the Proposed Action would not alter the physical or biological features essential to the conservation of ESA-listed spectacled and Steller’s eiders or their critical habitats, as they would be avoided as potential locations to conduct gunnery training. The range of the ESA-listed short-tailed albatross, spectacled eider, and Steller’s eider do not overlap with the area in which gunnery training would occur. The ESA-listed marbled murrelet is unlikely to overlap with locations used for gunnery training as these would be more than 12 nm from shore.

Gunnery noise associated with the Proposed Action would not result in significant impacts to seabirds or result in significant harm to seabirds. Pursuant to the ESA, gunnery noise associated with the Proposed Action would have no effect on the ESA-listed marbled murrelet, short-tailed albatross, Steller’s eider, and spectacled eider. The Proposed Action would it result in the destruction or adverse modification of federally-designated critical habitat of the spectacled or Steller’s eider as it would not occur in the Arctic proposed action area. Pursuant to the MBTA, gunnery noise associated with the Proposed Action would not result in a significant adverse effect on migratory bird populations.

4.1.6.2 Impacts from Gunnery Noise Under the Alternatives 2 and 3

Alternative 2: Leasing

It is assumed that gunnery training would be conducted on a leased vessel, thus, gunnery noise from a leased vessel would be similar to what is in current use and the potential impact would be similar to what was analyzed under Alternative 1. Therefore, the potential impacts associated with gunnery noise under Alternative 2 are the same as under Alternative 1. Therefore, gunnery noise from Alternative 2 is not likely to significantly impact or result in significant harm to birds.

Alternative 3: No Action

Under the No Action Alternative, the Coast Guard would fulfill its missions in the Arctic and Antarctic using existing polar icebreaker assets, which are reaching the end of their service lives. The current polar icebreaker fleet would continue current operations. Therefore, as long as the current polar icebreaker fleet is operational and includes gunnery training, baseline conditions of the existing environment would remain unchanged and would not significantly impact or result in significant harm to birds. Once the current fleet of icebreakers are decommissioned and no longer in operation, the Coast Guard would no longer have polar icebreakers in their fleet and therefore, operations and training from a polar icebreaker would no longer occur.

4.1.7 Summary of Impacts from Acoustic Stressors

The acoustic stressors from the Proposed Action include underwater acoustic transmissions (e.g., navigational technologies), vessel noise, icebreaking noise, aircraft noise, and gunnery noise. Potential acoustic impacts may include auditory masking (a sound interferes with the audibility of another sound that marine organisms may rely on), PTS, TTS, or a behavioral response. In general, the Coast Guard would use a medium or heavy PIB that would operate navigational technologies, including radar and sonar while underway. Marine species within the Arctic and Antarctic proposed action areas may also be exposed to icebreaking noise associated with a PIB’s activities. In assessing the potential impact or harm to species from acoustic sources, a variety of factors were considered, including source characteristics, animal presence, animal hearing range, duration of exposure, and impact thresholds for those species that may be present. The Coast Guard evaluated the data and conducted an analysis of the species distribution and likely responses to the acoustic stressors based on available scientific literature. The Coast Guard also used specific methods, described in this PEIS, to quantify potential effects to marine mammals from icebreaking. Sea turtles were not assessed for exposure to icebreaking noise as their geographic range does not overlap with any area where icebreaking is likely to occur. Icebreaking noise is generally described as a low frequency non-impulsive sound. Similarly, vessel noise is also characterized as low frequency. As such, a species response to icebreaking noise would be expected to be similar to their response to vessel noise. Therefore, non-marine mammal biological resources, such as seabirds, fish, and invertebrates that may potentially overlap with the proposed icebreaking area were not analyzed using the NAEMO model because the model was developed only for marine mammals, so these resources were analyzed using qualitative methods. Sea turtles were not assessed for icebreaking sound exposure as their geographic ranges do not overlap any a proposed icebreaking areas.

4.1.7.1 Summary of Impacts to Species from Acoustic Stressors

Based on the analysis, impacts from acoustic sources associated with the Proposed Action are expected to result in, at most, minor to moderate behavioral responses over short and intermittent periods. Table

4-7 summarizes the potential acoustic impacts from acoustic stressors to fish, EFH, invertebrates, marine mammals, birds, and sea turtles. Underwater acoustic transmissions, vessel noise, icebreaking noise, aircraft noise, and gunnery noise would not result in significant impact or result in significant harm to invertebrates, fish, essential fish habitat, birds, sea turtles, and marine mammals. Those species listed as endangered or threatened under section 7 of the ESA, would not be expected to respond in ways that would significantly disrupt normal behavior patterns which include, but are not limited to: migration, breathing, nursing, breeding, feeding, or sheltering. Acoustic stressors from the Proposed Action would not cause population level effects to any ESA-listed species in the proposed action areas. Additionally, the Coast Guard would avoid all known critical habitat areas. For those species where authorizations or permits may be required, the Coast Guard would consult with the appropriate regulatory agency to ensure environmental compliance. The timing of this permit request would coincide more closely with the time the first PIB is operational, due to expected updates to information and potential changes to a species listing status.

4.1.7.2 Summary of Impacts to Critical Habitat from Acoustic Stressors

As described above, the Coast Guard will avoid all known critical habitat areas (see Chapter 6). Pursuant to the ESA, acoustic transmissions, vessel noise, aircraft noise, icebreaking noise, and gunnery noise associated with the Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat of the Steller's eider, spectacled eider, North Pacific right whale, polar bear, Southern Resident killer whale, Steller sea lion, or proposed ring seal critical habitat. No other critical habitat overlaps the proposed action areas; therefore, there will be no effect to critical habitat outside of the Arctic and Pacific Northwest proposed action areas.

4.1.7.3 Summary of Impacts from Acoustic Stressors Under the Alternatives 2 and 3

Alternative 2: Leasing

It is assumed that underwater acoustic transmissions, vessel noise, icebreaking noise, aircraft noise, and gunnery noise associated with Alternative 2 would be similar to what is in current use and the potential impact would be similar to what was analyzed under Alternative 1. Therefore, the potential impacts associated with these stressors under Alternative 2 are the same as under Alternative 1. Therefore, underwater acoustic transmissions, vessel noise, icebreaking noise, aircraft noise, and gunnery noise associated with Alternative 2 are not likely to significantly impact or result in significant harm to invertebrates, fish, EFH, birds, sea turtles, or marine mammals.

Alternative 3: No Action

Under the No Action Alternative, the Coast Guard would fulfill its missions in the Arctic and Antarctic using existing polar icebreaker assets, which are reaching the end of their service lives. The current polar icebreaker fleet would continue current operations. Therefore, as long as the current polar icebreaker fleet is operational and includes air support and gunnery training, baseline conditions of the existing environment would remain unchanged and would not significantly impact or result in significant harm to invertebrates, fish, EFH, seabirds, sea turtles, and marine mammals. Once the current fleet of icebreakers are decommissioned and no longer in operation, the Coast Guard would no longer have polar icebreakers in their fleet and therefore, operations and training from a polar icebreaker would no longer occur.

4.2 Physical Stressors

4.2.1 Vessel Movement

The Proposed Action includes a medium or heavy icebreaker as the primary vessel with additional small boats to support icebreaker operations. The operational speeds of these vessels would dependent on the task and the type of task. Vessels would not be operating at their maximum speeds unless involved in an emergency situation. While Coast Guard trains and prepares to respond to emergency situations, the emergency response itself is not part of the Proposed Action; therefore, maximum speeds are not expected as part of the Proposed Action.

The PIB would tow or escort any vessels in need, especially vessels that are stuck in the ice in the Arctic or Antarctic proposed action areas. The PIB crew would need to conduct annual vessel tow training to carry out Coast Guard missions. Based on historical operations, towing vessels occurred in the Antarctic proposed action area and included: tows to open water occurring once per year, and tows off a pier occurring twice per year. Towing lines would be used to tow the vessel and speeds of 4–5 knots are typical for a vessel tow.

Marine species within the proposed action areas may be exposed to vessel movement associated with Coast Guard assets during the Proposed Action. It is difficult to differentiate between behavioral responses to vessel sound and visual cues associated with the presence of a vessel (Hazel et al. 2007); thus, it is assumed that both play a role in prompting reactions from animals. Vessels have the potential to impact or harm resources by altering their behavior patterns or causing mortality or serious injury from vessel collisions. Reactions to vessels often include changes in general activity (e.g., from resting or feeding to active avoidance), changes in surface respiration or dive cycles (marine mammals), and changes in speed and direction of movement. The severity and type of response exhibited by an individual may also include previous encounters with vessels. Some species have been noted to tolerate slow-moving vessels within several hundred meters, especially when the vessel is not directed toward the animal and when there are no sudden changes in direction or engine speed (Richardson et al. 1995).

No impact or harm to invertebrates, fish, seabirds, sea turtles, and marine mammals is expected from vessel movement or vessel tow training. Under the Proposed Action vessel movement would not alter the physical or biological features essential to the conservation of ESA-listed species. Therefore, vessel movement would not result in the destruction or adverse modification of federally-designated critical habitat. The potential impact or harm of vessel movement on invertebrates, seabirds, fish, Essential Fish Habitat, sea turtles, and marine mammals is provided in more detail below.

4.2.1.1 Invertebrates

Vessels have the potential to impact or harm marine invertebrates either by disturbing the water column (Bishop 2008) or directly striking the organism. Vessel movement may result in short-term and localized disturbances to invertebrates, such as zooplankton and cephalopods in the upper water column. Propeller wash (water displaced by propellers used for propulsion) from vessel movement can potentially disturb marine invertebrates in the water column and are a likely cause of zooplankton mortality (Bickel et al. 2011). Since most of the macro invertebrates within the proposed action areas are benthic and the Proposed Action takes place in the upper water column, potential for vessel strike of macro invertebrates is extremely low. Although the tow cable and towed vessel may impact or harm invertebrates encountered along a tow route, the chance that such an encounter would result in serious injury is extremely remote because of the low probability that an individual of a species would overlap with the infrequent tow training events. No measurable effects to invertebrate populations in the water column would be expected because the number of organisms potentially exposed to vessel movement or vessel tow training would be low when compared to the total invertebrate biomass in the proposed action areas. Although some invertebrates could be disturbed or killed by a vessel collision or tow cable strike, population level impacts are not anticipated.

Devices that pose an entanglement risk are those with lines or tethers; devices associated with the Proposed Action with a potential for entanglement include the lines used in the towing of vessels. For an organism to become entangled in a line or material, the materials must have certain properties, such as the ability to form loops and a high breaking strength. Towing lines would not be expected to have any loops or slack. Entanglement in tow lines is unlikely and would not impact or harm invertebrates as they cannot become entangled in lines from in-water devices.

Vessel movement and vessel tow training associated with the Proposed Action would not result in significant impacts to invertebrates or result in significant harm to invertebrates. There are no ESA-listed invertebrates within the proposed action areas.

4.2.1.2 Fish

Fish within the proposed action areas may be exposed to vessel movement associated with Coast Guard vessels during the Proposed Action. Fish species within the proposed action areas are distributed throughout the entire water column. In most of the proposed action areas, the majority of the biomass is benthic, and therefore not at risk of a vessel collision. The potential for a pelagic fish to be struck by a vessel associated with the Proposed Action would be extremely low, because most fish can detect and avoid vessel movements. As a vessel approaches a fish, they could have a detectable behavioral or physiological response (e.g., swimming away and increased heart rate) as the passing vessel displaces them. Regardless of vessel speeds, vessel collisions with fish are possible. Although the tow cable and towed vessel may impact or harm fish encountered along a tow route, the chance that such an encounter would result in serious injury is extremely remote because of the low probability that an individual of a species would overlap with the infrequent tow training events. Any isolated cases of vessels striking an individual fish could injure or kill an individual fish, but would not be expected to have population level impacts. Potential impact or harm from exposure to vessels would only very rarely result in substantial changes to behavior, and these changes would likely be minor and temporary. Vessel movement may cause short-term and local displacement of fish in the water column. Therefore, population level impacts or impacts to fitness and recruitment would not be expected to occur.

Devices that pose an entanglement risk are those with lines or tethers; devices associated with the Proposed Action with a potential for entanglement include the lines used in the towing of vessels. For an organism to become entangled in a line or material, the materials must have certain properties, such as the ability to form loops and a high breaking strength. Towing lines would not be expected to have any loops or slack. In theory, there exists a remote possibility that a fish could become entangled in a line during deployment or retrieval. If entangled in such a way, the individual fish could be stressed, injured, or killed. However, it is likely that the noise produced by the vessel would cause most fish to flee the immediate area surrounding the vessel, and would therefore not be likely to be in a position to become entangled. The possibility of injury or mortality to an individual fish is remote, but present. However, there would be no population level impacts on any fish species as a result of entanglement, because the number of individuals impacted would be few, if any. It is not anticipated that vessel tow training would impact EFH as it cannot become entangled in the tow lines.

Vessel movement and vessel tow training associated with the Proposed Action would not result in significant impacts to fish or result in significant harm to fish. Pursuant to the ESA, entanglement associated with the Proposed Action would have no effect on ESA-listed fish because ESA-listed fish would not be present in the vessel tow training area. Pursuant to the ESA, vessel movement associated with the Proposed Action may affect, but is not likely to adversely affect ESA-listed bocaccio, Chinook salmon, chum salmon, coho salmon, Pacific eulachon, sockeye salmon, steelhead trout, and yelloweye rockfish. Vessel movement through the species' range would be discountable or insignificant. The Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat for ESA-listed fish as it is located outside of the proposed action areas.

4.2.1.3 Seabirds and Shorebirds

Seabirds in the proposed action areas may be exposed to vessel movement associated with Coast Guard vessels during the Proposed Action. It is difficult to differentiate between behavioral responses to vessel sound and visual cues associated with the presence of a vessel (Hazel et al. 2007); thus, it is assumed that both play a role in prompting reactions from animals. Seabirds are a visually oriented species and as a result, the majority of bird-vessel collisions have occurred at night when birds become disoriented in the presence of artificial lights from vessels (Glass and Ryan 2013; Huntington et al. 2015; Merkel 2010; Ryan 1991). Attraction to light can result in seabirds circling the light source for a period of time before getting their bearings. Birds have also been observed landing on vessels that generate the light source and remaining until the lights are turned off, and birds have been observed flying headlong into the vessel's superstructure and dying upon impact (Ryan 1991). Thus, the probability of a seabird colliding with a vessel increases at night and in situations of poor visibility such as snow, rain, or fog (Glass and Ryan 2013; Huntington et al. 2015; Merkel 2010; Ryan 1991). In a study offshore Greenland, Merkel (2010) found that 93 percent of bird-vessel strikes occurred less than 2 nm from shore, all bird strikes occurred between 4:00 pm and 5:00 am, and significantly more birds were killed when visibility was poor rather than when it was moderate or good. Also, species that fly just over the water's surface at high speeds, such as eiders, petrels, and shearwaters, appear to be more susceptible to vessel strike than slower, higher flying species (Glass and Ryan 2013; Merkel 2010; Ryan 1991).

The Proposed Action would typically involve vessels operating at distances greater than 2 nm offshore, where vessels would be less likely to encounter seabirds. During daylight and due to their excellent eyesight (Birkhead 2013) and maneuverability (Warrick et al. 2002) seabirds could avoid oncoming vessels; therefore, the likelihood that a seabird would collide with a vessel is low. For example, in their study of flight speeds across all major seabird taxa (98 species total), Spear and Ainley (1997) recorded average ground speeds of between 10.7 and 43.3 knots, whereas typical transit speeds associated with the Proposed Action are between 10–12 knots.

Despite these flight speeds, and regardless of vessel speeds, vessel collisions with birds are possible, particularly during periods of reduced visibility. The likelihood that a bird species flying at higher altitudes would be lower than species that fly closer to the water's surface. Although the tow cable and towed vessel may impact or harm seabirds encountered along a tow route, the chance that such an encounter would result in serious injury is extremely remote because of the low probability that an individual of a species would overlap with the infrequent tow training events. In the unlikely event of a collision with a bird occurs, this would not result in population level impacts. Behavioral reactions to vessel movement or vessel tow training may include avoidance or following the vessels. As a variety of vessel traffic currently uses both the Pacific Northwest and Arctic proposed action areas, seabirds may be habituated to vessel movement in these areas.

The vast majority of penguin species in the Ross Sea are Adélie and emperor penguins. Adélie penguins breed on land, and emperor penguins breed on sea ice in the austral autumn. Thus, neither species would be exposed to vessel movement during icebreaking operations (which occur during the austral summer) while breeding. Penguins who may forage during this time, would be relatively mobile in the water and likely able to avoid the icebreaker by swimming out of its path. However, in January and February, both species of penguin molt in the eastern Ross Sea, which includes the Antarctic proposed action area. Penguins cannot swim during their molt period, since their new feathers are not waterproof. Although infrequent, there may be some instances when molting penguins, who are unable to enter the water, would not be able to exit the path of the icebreaker. However, it is unlikely that a molting penguin would be found in the area where the icebreaker would be icebreaking or crews would be vessel tow training. Should the vessel collide with a penguin, it would be extremely rare, but it would not translate to population level impacts.

Vessel movement associated with the Proposed Action would not alter the physical or biological features essential to the conservation of ESA-listed seabird species. Vessel presence would be diffuse and spread throughout the proposed action areas. As a result, any response caused by the Proposed action would be limited to a behavioral disturbance, which would be temporary and localized to the position of the vessel. Seabirds would likely not respond to vessel movement or vessel tow training or if they did respond, the response would not significantly disrupt normal behavior patterns which include, but are not limited to: migration, breeding, feeding, or sheltering. Coast Guard vessels would maintain properly trained lookouts and would not intentionally approach large flocks of seabirds, would follow the Coast Guard's SOPs and BMPs (see Chapter 6). and therefore, the effect to seabirds from vessel movement or vessel tow training is expected to be temporary. Vessels would avoid designated critical habitats.

Vessel movement and vessel tow training associated with the Proposed Action would not result in significant impacts to sea birds or result in significant harm to seabirds. Pursuant to the ESA, vessel movement associated with the Proposed Action may affect, but is not likely to adversely affect the ESA-listed marbled murrelet, short-tailed albatross, Steller's eider, and spectacled eider. Vessels would avoid nearshore shallow critical habitat designated for the ESA-listed Steller's eider. Critical habitat for the ESA-listed spectacled eider includes a wintering area (that changes annually) in the opening of the ice in the Bering Sea. Vessels would avoid visible large gatherings of animals, including large groupings of spectacled eiders. As a result, vessel movement would not alter any resources essential to the conservation of ESA-listed seabirds. The Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat for the spectacled or Steller's eider. In accordance with the MBTA, vessel movement associated with the Proposed Action would not result in a significant adverse effect on migratory bird populations.

4.2.1.4 Sea Turtles

Sea turtles within the proposed action areas may be exposed to vessel movement during the Proposed Action. Sea turtles would not overlap with vessel tow training events. Sea turtles could detect approaching vessels, likely by sight rather than by sound (Bartol and Ketten 2006; Hazel et al. 2007). Sea turtles have been observed to exhibit short-term responses in their reaction to vessels, with a reaction time dependent on the speed of the vessel (Hazel et al. 2007). Sea turtles have been documented to flee frequently when encountering a slow-moving (e.g., 2 knots) vessel, but infrequently when encountering a moderate-moving (e.g., 6 knots) vessel, and only rarely when encountering a faster-moving (e.g., 10 knots) vessel. During the Proposed Action, vessels would typically transit ice-free waters at 10–12 knots.

Although sea turtles would likely hear and see approaching vessels, a risk of a vessel collision with a sea turtle exists due to the co-occurrence of vessels and sea turtles. High-speed collisions with large objects can be fatal to sea turtles.

However, sea turtles spend most of their time submerged (Renaud and Carpenter 1994; Sasso and Epperly 2006), which would reduce their risk of a vessel collision with those vessels participating in the proposed action activities. Sea turtles are also widely distributed across the world's oceans and icebreakers would be operating in widespread areas across open ocean. Further, Coast Guard activities would avoid areas where sea turtles are expected and along with the SOPs and BMPs in Chapter 6, the likelihood of a collision with a sea turtle would be low.

Vessel movement associated with the Proposed Action would not result in significant impacts to turtles or result in significant harm to turtles. Pursuant to the ESA, vessel movement associated with the Proposed Action may affect, but is not likely to adversely affect the ESA-listed leatherback turtle. Pursuant to the ESA, vessel movement would have no effect on leatherback sea turtle critical habitat as vessel operations would avoid designated critical habitat for the leatherback sea turtle.

4.2.1.5 Marine Mammals

Marine mammals within the proposed action areas may be exposed to vessel movement and vessel tow training during the Proposed Action. Interactions between surface vessels and marine mammals have demonstrated that surface vessels represent a source of acute and chronic disturbance for marine mammals (Au and Green 2000; Bejder et al. 2006; Hewitt 1985; Jefferson et al. 2009; Kraus et al. 1986; Magalhães et al. 2002; Nowacek et al. 2004; Richter et al. 2008; Richter et al. 2003; Williams et al. 2009). In some circumstances, marine mammals respond to vessels with the same behavioral repertoire and tactics they employ when they encounter predators. It is not clear what environmental cues marine mammals might respond to–the sound of water being displaced by the ships, the sound of the ships' engines, or a combination of environmental cues surface vessels produce while they transit.

Vessel collisions are a well-known source of mortality in marine mammals, and can be a significant factor affecting some large whale populations (Berman-Kowalewski et al. 2010; Jensen and Silber 2003; Knowlton and Kraus 2001; Laist et al. 2001; Neilson et al. 2012; Redfern et al. 2013; Van Waerebeek et al. 2007; Vanderlaan et al. 2009; Vanderlaan et al. 2008). During a review of data on the subject, Laist et al. (2001) compiled historical records of ship strikes, which contained 58 anecdotal accounts. It was noted that in the majority of cases, the whale was either not observed or seen too late to maneuver in an attempt to avoid collision. The most vulnerable marine mammals to collision are thought to be those that spend extended periods at the surface or species whose unresponsiveness to vessel sound makes them more susceptible to vessel collisions (Gerstein 2002; Laist and Shaw 2006; Nowacek et al. 2004). Another important variable is ship speed, as lethal vessel collisions are more likely at higher vessel speeds (Gende et al. 2011; Vanderlaan and Taggart 2007; Wiley et al. 2011). Laist et al. (2001) noted that most severe and fatal injuries to marine mammals occurred when the vessel was traveling in excess of 14 knots; meanwhile, Vanderlaan and Taggart (2007) found that the greatest risk of a lethal strike was when the vessel reached speeds of 8.6 to 15 knots. Although the maximum speed of the icebreaker during vessel propulsion testing is 12–17 knots, a PIB is expected to operate at slower speeds during most of the Proposed Action activities. Small support boats (up to two transferring passengers) deployed off a PIB could travel at a maximum speed of 15 knots. However, while slow speed does decrease the chance of a fatal collision, it will not eliminate the risk of a collision or that if a collision occurs that it would result in serious injury or mortality. Vanderlaan and Taggart (2007) concluded that at speeds below 8 knots, there was still a 20 percent risk of death from blunt trauma. Small support boats would be expected to travel at or below their maximum speed of 15 knots.

Marine mammals such as dolphins, porpoises, and pinnipeds do not appear to be as susceptible to vessel collisions, though the risk of a collision still exists for these species. Since 1998, the Coast Guard has reported 12 collisions with whales in the waters of the U.S. EEZ. In the past 10 years (2006–2016 and into 2017), Coast Guard vessels have reported eight collisions with whales in the waters of the U.S. EEZ. Specifically, off the U.S. West Coast (California to Alaska), collisions with seven whales were reported during that same time period. However, none of these collisions were caused by a Coast Guard icebreaker or similar class vessels, even though several Coast Guard icebreakers have been operating in the proposed action areas for roughly half a century. The Coast Guard has also improved watchstander training (e.g., lookout training), placing an emphasis on marine protected species awareness. The improved training would likely decrease the risk of a marine-mammal-vessel collision below historic data. Included in this estimate was a collision with a sperm whale in 2017 near Samalga Pass, Alaska (NMFS Marine Mammal Health and Stranding Database[12]). As a federal agency and co-investigator with NMFS, Coast Guard is required to report all whale strikes to NMFS.

Few authors have specifically described the responses of pinnipeds to vessels, and most of the available information on reactions to boats concerns pinnipeds hauled out on land or ice. Brueggeman et al. (1992) stated ringed seals hauled out on the ice showed short-term escape reactions when they were within 820 to 1640 ft (0.25 to 0.5 km) of a vessel. From the limited data available, it appears that pinnipeds are not as susceptible to vessel collisions as other marine mammal species. This may be due, at least in part, to the large amount of time they spend on land or ice (especially when resting and breeding) and their high maneuverability in the water. However, pinniped carcasses do not typically wash up in an area where they can be reported to the local stranding network, or a necropsy is unable to be performed to determine cause of death, so incidents of reporting a vessel collision as cause of death are low.

Polar bears do not appear to be significantly affected by vessel moment. Some polar bears have been observed walking, running, or swimming away from approaching vessels, but these reactions were brief and localized. Other polar bears have been observed approaching vessels or having no reaction to vessels (Richardson et al. 1995). Because polar bears spend much of their time out of water, some proportion of the time that a vessel may near a polar bear it may be on ice where there is a decreased risk for strike.

As mentioned above, large whales appear to be more susceptible to vessel collisions, more than any other marine mammal species. Bowhead whales often begin avoiding vessels from more than 2.2 nm away (Richardson et al. 1995). Avoidance by this species usually entails altered headings, faster swimming speeds, and shorter amounts of time spent surfacing. Bowhead whales are more tolerant of vessels moving slowly or moving in directions other than towards them. In most studies, observers noted bowhead whales exhibiting avoidance within 1,640 ft (500 m) of vessels, though avoidance at further distances was not able to be judged by observers on vessels (Richardson et al. 1995). Large delphinids have reactions to vessels ranging from avoidance to bow riding. Sperm whales react to most vessels by changing course and diving to more shallow depths (Gaskin 1964; Reeves et al. 2002).

[12] Information received on August 15, 2017 from NMFS Marine Mammal Health and Stranding Program.

Devices that pose an entanglement risk are those with lines or tethers; devices associated with the Proposed Action with a potential for entanglement include the lines used in the towing of vessels. For an organism to become entangled in a line or material, the materials must have certain properties, such as the ability to form loops and a high breaking strength. Towing lines would not be expected to have any loops or slack. Because the winch wire and lines for towing activities discussed in the Proposed Action would be under tension if in the water column, it would be expected that wire or lines would remain predominantly taut during the majority of operations. The amount of time that the line is in the same vicinity as a marine mammal can increase the likelihood of it posing an entanglement risk. The length of the line would vary and greater lengths may increase the likelihood that a marine mammal could become entangled. The behavior and feeding strategy of a species can influence whether they may incidentally encounter lines in the water column (e.g., a lunge-feeding baleen whale). However, proposed activities would avoid any marine mammal feeding or breeding areas, therefore eliminating the possibility of entanglement during feeding or breeding.

Although the tow cable and towed vessel may impact or harm marine mammals encountered along a tow route, the chance that such an encounter would result in serious injury is extremely remote because of the low probability that an individual of a species would overlap with the infrequent tow training events. Vessel crews would be trained in marine mammal identification and would alert the Commanding Officer of the presence of marine mammals and initiate adaptive mitigation responses and would follow SOPs and BMPs (see Chapter 6), which could include delaying the vessel tow training until marine mammals are no longer present or moving the training to a location where few marine mammals are present.

Based on these studies, if a mammal were to encounter a vessel, any behavioral avoidance displayed is expected to be short-term and inconsequential. Vessel movement would not be expected to significantly disrupt behavioral patterns such as migration, breathing, nursing, breeding, feeding and sheltering to a point where the behavior pattern is abandoned or significantly altered or result in reasonably foreseeable takes of marine mammals. In order to comply with laws protecting ESA-listed species (and would also benefit non ESA-listed species), Coast Guard would plan passage around marine sanctuaries, such as federally-designated critical habitat. These actions would minimize the effect of vessel movement to polar bears and their federally-designated critical habitat.

The probability of a vessel encountering a marine mammal is expected to be low, which decreases the likelihood of vessels striking marine mammals. Vessel crews would be trained in marine mammal identification and would alert the Commanding Officer of the presence of marine mammals and initiate adaptive mitigation responses and would follow SOPs and BMPs (see Chapter 6). Mitigation measures include reducing vessel speed, posting additional dedicated lookouts to assist in monitoring marine mammal locations, avoiding sudden changes in speed and direction, or, if a swimming marine mammal is spotted, attempting to parallel the course and speed of the moving animal so as to avoid crossing its path, and avoiding approaching sighted marine mammals head-on or directly from behind. Coast Guard would support the recovery of protected living marine resources through internal compliance with laws designed to preserve marine protected species, including planning passage around marine sanctuaries, such as federally-designated critical habitat. These actions would minimize the impact or harm of vessel movement to marine mammals and federally-designated critical habitat. In addition, in the extremely unlikely event of a vessel collision with a marine mammal, the Coast Guard would immediately contact the NMFS Regional stranding coordinator and the appropriate Regional Office.

Vessel movement and vessel tow training associated with the Proposed Action would not alter the physical or biological features essential to the conservation of ESA-listed marine mammals. If a mammal were to encounter a vessel, any behavioral avoidance response would be expected to be temporary and the animal would be expected to return to their pre-disturbance behavior. Vessel movement would not be expected to significantly disrupt behavioral patterns such as migration, breathing, nursing, breeding, feeding and sheltering to a point where the normal behavior pattern is abandoned or significantly altered. Vessel collisions could result in injury or mortality of marine mammals; however, vessel collisions are unlikely given the Coast Guard's mitigation measures and SOPs and BMPs (see Chapter 6).

Vessel movement and vessel tow training from the Proposed Action is not likely to significantly impact marine mammals or result in significant harm marine mammals. Pursuant to the ESA, vessel movement may affect, but is not likely to adversely affect the ESA-listed blue whale, bowhead whale, fin whale, gray whale, humpback whale, North Pacific right whale, polar bear, sei whale, Southern Resident killer whale, sperm whale, bearded seal, ringed seal, or Steller sea lion. Pursuant to the ESA, deployment of lines or tethers associated with the Proposed Action would have no effect on Southern Resident killer whales as vessel tow training would not overlap with this species. Pursuant to the ESA, vessel tow training may affect, but is not likely to adversely affect ESA-listed blue whale, bowhead whale, fin whale, gray whale, humpback whale, North Pacific right whale, sei whale, sperm whale, bearded seal, ringed seal, or Steller sea lion. Coast Guard proposed action activities would avoid critical habitat for the Southern Resident killer whale, as it is located outside of the proposed action areas. Coast Guard may need to transit designated critical habitat for the Southern Resident killer whale, post dry dock, if the homeport is Seattle, Washington, en route to the Pacific Northwest proposed action area. Coast Guard would follow SOPs and BMPs to reduce the risk of any impacts to Southern Resident killer whale critical habitat. Coast Guard would also follow SOPs and BMPs and avoid designated critical habitat for the Steller sea lion, as it is located close to islands and rookeries, which would also pose a navigational hazard for a PIB. Vessel movement associated with the Proposed Action would not alter primary copepod prey species essential to the conservation of ESA-listed North Pacific right whales. Vessel movement and tow training would occur in open waters and not within or near terrestrial or sea ice denning sites for polar bears or sea ice lairs for ringed seal. Therefore, vessel movement and tow training associated with the Proposed Action would not alter primary features essential to the conservation of ESA-listed marine mammals. The Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat for the North Pacific right whale, polar bear, Southern Resident killer whale, Steller sea lion, or the proposed ringed seal critical habitat.

4.2.1.6 Impacts from Vessel Movement Under the Alternatives 2 and 3

Alternative 2: Leasing

It is assumed that vessel movement and vessel tow training from a leased vessel would be similar to what is in current use and the potential impact would be similar to what was analyzed under Alternative 1. Therefore, the potential impacts associated with vessel movement and vessel tow training under Alternative 2 are the same as under Alternative 1. Therefore, vessel movement and vessel tow training from Alternative 2 is not likely to significantly impact or result in significant harm to invertebrates, fish, birds, sea turtles, and marine mammals.

Alternative 3: No Action

Under the No Action Alternative, the Coast Guard would fulfill its missions in the Arctic and Antarctic using existing polar icebreaker assets, which are reaching the end of their service lives. The current polar icebreaker fleet would continue current operations. Therefore, as long as the current polar icebreaker fleet is operational, baseline conditions of the existing environment would remain unchanged and would not significantly impact or result in significant harm to invertebrates, fish, birds, sea turtles, and marine mammals. Once the current fleet of icebreakers are decommissioned and no longer in operation, the Coast Guard would no longer have polar icebreakers in their fleet and therefore, operations and training from a polar icebreaker would no longer occur.

4.2.2 Aircraft Movement

The aircraft utilized during the Proposed Action would be the MH-60 Jayhawk helicopter. Normal cruising speed of the MH-60 Jayhawk is 135 to 140 knots and the aircraft is capable of reaching 180 knots for short durations. The Coast Guard may also use UAVs for ice reconnaissance and in order to collect data for imaging purposes, it is expected that flight speeds would be much slower (i.e., <50 mi/hr [80 km/hr]) than expected helicopter flight speeds. Therefore, potential impacts from UAV use would be less than those from helicopter flights. Helicopter flights associated with the Proposed Action would be used for transport of personnel and equipment and for conducting training (e.g., qualifications). In general, flights for routine patrols could occur at 400–1,500 ft (122–457 m) in altitude, but typically, aircraft stay at or above 1,000 ft (305 m), when possible.

Aircraft would not operate at an altitude lower than 1,500 ft (457 m) within 0.5 mi (805 m) of marine mammals observed on ice or land. Helicopters would also not hover or circle above such areas. Per the Coast Guard Air Operations Manual (COMDTINST M3710.1G) aircraft would avoid any identified environmentally sensitive areas, to include, but not be limited to, critical habitat designated under the ESA, migratory bird sanctuaries, and marine mammal haulouts and rookeries. However, if aircraft need (e.g., personnel safety) to pass over such areas (e.g., personnel safety), aircraft would stay above 3,000 ft (914 m).

Search and Rescue air searches for persons in the water or a vessel in distress, may require that the helicopter fly at an altitude below 500 ft (152 m). Emergency recovery of persons in the water and transfer of rescue equipment would also require that the helicopter hover below 500 ft (152 m). Any Coast Guard response during a search and rescue mission is considered an emergency and is not a part of the Proposed Action. However, normal operations and training for a SAR is part of the Proposed Action. As stated previously, environmentally sensitive areas would be avoided and flights would be expected to stay above 1,500 ft (457 m). Any SAR training that may require helicopters to fly below 1,500 ft (457 m), would avoid environmentally sensitive areas and areas where ESA-listed species are known to occur. As the Coast Guard does not expect to land on the ice with a helicopter, only ESA-listed seabirds could potentially be exposed, and therefore struck by, a helicopter.

Since aircraft associated with the Proposed Action would avoid ESA-listed species that are visibly hauled out or travelling on land (e.g., polar bears), there will be no effect to ESA-listed marine mammals from aircraft or UAV movement. There would be no effect to ESA-listed marbled murrelet from UAV movement as no UAVs are deployed within the Pacific Northwest proposed action area.

There would be no impact or harm to invertebrates, fish, EFH, sea turtles, or marine mammals from aircraft or in-air device movement associated with the Proposed Action. Seabirds are the only resource that may be impacted or harmed by aircraft movement. The potential impact or harm to seabirds is described in detail below.

4.2.2.1 Seabirds and Shorebirds

As noted in Section 4.1.5.2, seabirds generally remain well below the typical helicopter flight altitudes (i.e., 1,000 ft [305 m]) associated with the Proposed Action. Average seabird flight altitudes typically range between 33 – 130 ft. (10 – 40 m), depending on the species, with most species flying at the lower end of this range (Cook et al. 2012; Day et al. 2005; Krijgsveld et al. 2005). Thus, it is unlikely that a large number of birds would be struck by normal helicopter operations. Bird and aircraft encounters are also more likely to occur during aircraft takeoffs and landings than when the aircraft is engaged in level flight. In a study of reported bird strikes to civil aircraft from 1990 to 2005, 60 percent of strikes occurred below 100 ft (30.5 m) and 74 percent of strikes occurred below 500 ft (150 m) (Cleary et al. 2006). However, the helicopter would spend more time in transit than it would to take off and land. Birds would be most at risk of a strike during takeoff and landing because the helicopter is passing through the lower altitudes where these birds may be found. Bird strikes are a serious concern for helicopter crews not only because of the risk to the birds, but also because they can harm aircrews and equipment. For this reason, Coast Guard would avoid large flocks of birds to increase personnel safety and minimized any risk associated with a bird-aircraft strike and would follow SOPs and BMPs (see Chapter 6).

Thus, while there is some risk of an aircraft -seabird strike associated with the Proposed Action, due to the Coast Guard mitigation measures; limited duration of aerial operations (especially in the typical altitude ranges of seabirds and migratory shorebirds); and, avoidance by seabirds, the risk of a strike is low. Should a collision occur, bird mortality or injuries due to the strike caused by helicopter or UAV movement may result, but population level impacts to seabirds are not expected. Aircraft and UAVs associated with the Proposed Action would not alter the physical or biological features essential to the conservation of ESA-listed seabird species. Flight paths in the Arctic and Antarctic proposed action areas are planned to avoid critical habitat areas and areas where there are known gatherings of seabirds, such as the Bering Sea wintering area. While flights would concentrate departures from established FOLs in the Arctic proposed action area, flight paths would be dispersed widely throughout the area in order to land on the transient PIB wherever it is located. Flights in the Antarctic would not be as dispersed as those in the Arctic proposed action area, but flights would avoid any known aggregations of seabirds, such as penguin colonies. Seabirds are either not likely to respond to aircraft and UAV or are not likely to respond in ways that would significantly disrupt normal behavior patterns which include, but are not limited to: migration, breeding, feeding, or sheltering. Coast Guard would maintain properly trained lookouts and would not purposefully approach large flocks of seabirds and follow SOPs and BMPs (see Chapter 6). Thus, the effect to seabirds from aircraft movement is expected to be temporary.

Aircraft and in-air device movement associated with the Proposed Action would not result in significant impacts to seabirds or result in significant harm to birds. Pursuant to the ESA, aircraft movement associated with the Proposed Action may affect, but is not likely to adversely affect the ESA-listed marbled murrelet, short-tailed albatross, Steller’s eider, and spectacled eider. UAV movement associated with the Proposed Action may affect, but is not likely to adversely affect the ESA-listed short-tailed albatross, Steller’s eider, and spectacled eider. There would be no effect to ESA-listed marbled murrelet from UAV movement as no UAVs are deployed within the Pacific Northwest proposed action area. Aircraft and UAV movement would not result in the destruction or adverse modification of federally-designated critical habitat for the spectacled or Steller’s eider. Pursuant to the MBTA, aircraft and in-air device movement associated with the Proposed Action would not result in a significant adverse effect on migratory bird populations.

4.2.2.2 Impacts from Aircraft Movement Under the Alternatives 2 and 3

Alternative 2: Leasing

It is assumed that aircraft would be used in support of a leased vessel, thus, aircraft movement from a leased vessel would be similar to what is in current use and the potential impact would be similar to what was analyzed under Alternative 1. Therefore, the potential impacts associated with aircraft movement under Alternative 2 are the same as under Alternative 1. Therefore, aircraft movement from Alternative 2 is not likely to significantly impact or result in significant harm to birds.

Alternative 3: No Action

Under the No Action Alternative, the Coast Guard would fulfill its missions in the Arctic and Antarctic using existing polar icebreaker assets, which are reaching the end of their service lives. The current polar icebreaker fleet would continue current operations. Therefore, as long as the current polar icebreaker fleet is operational and includes air support, baseline conditions of the existing environment would remain unchanged and would not significantly impact or result in significant harm to seabirds. Once the current fleet of icebreakers are decommissioned and no longer in operation, the Coast Guard would no longer have polar icebreakers in their fleet and therefore, operations and training from a polar icebreaker would no longer occur.

4.2.3 AUV Movement

An AUV is an in-water device that is associated with the Proposed Action that may be deployed to observe the ice conditions in the Arctic proposed action area. The AUV would be deployed from a PIB, which would be stationary or travelling up to three knots during deployment. The AUV itself can travel at speeds of up to 10 knots and may be deployed for a maximum of 24 hours and then retrieved. It is not anticipated that the movement of AUVs would impact or harm EFH. A summary of the impact or harm to invertebrates, fish, seabirds, and marine mammals is provided in detail below.

4.2.3.1.a Invertebrates

The potential for an invertebrate strike by the AUV is similar to that identified for vessels. Invertebrates using the upper water column may encounter short-term and localized disturbances, including limited mortality. However, no long-term or population level effects are expected as the amount of biomass that would potentially be impacted or harmed is insignificant relative to the overall biomass of the system.

In-water device movement associated with the Proposed Action would not result in significant impacts to invertebrates or result in significant harm to invertebrates. There are no ESA-listed invertebrates within the proposed action areas.

4.2.3.1.b Fish

AUVs would be deployed off the side of the vessel at the surface and then would travel through the water column. There is a remote potential for strike with fish in the path of the device. Before a potential strike, some fish would sense a pressure wave through the water and respond by remaining in place, moving away from the object, or moving toward it (Hawkins and Johnstone 1978). Any fish displaced a small distance away by movements from an object nearby, such as an AUV, would likely resume normal activities after a brief disturbance. However, others could be disturbed and may exhibit a generalized stress response. If the AUV actually hit the fish, direct injury or mortality in addition to stress may result. The function of the stress response in vertebrates is to rapidly raise the blood sugar level to prepare the organism for the fight or flight response (Helfman 2009).

The potential for a fish to be struck by an AUV is similar to that identified for vessels. The likelihood of collision is low given the high mobility of most fish and their ability to detect and avoid approaching objects (National Oceanic and Atmospheric Administration 2011). The ability of a fish to return to what it was doing following a physical strike (or near miss resulting in a stress response) is a function of fitness, genetic, and environmental factors. Some organisms are more tolerant of environmental or human-caused stressors than others are and become acclimated more easily. An individual's response would also be expected to vary. However, the potential for fish to be close to an AUV during deployment is very low. A possibility exists that a small number of fish at or near the surface may be directly impacted if they are in the area of deployment. However, the likelihood of this is similarly small, and if impacted, the portion of the population impacted would be extremely small. Therefore, no long-term or population level effects on any fish species from an AUV would be expected. AUVs may result in short-term and local displacement of fish in the water column. However, these behavioral reactions are not expected to result in significant changes to an individual's fitness, or species recruitment, and are not expected to result in population level impacts. Ichthyoplankton (fish eggs and larvae) exposed to AUVs would be extremely low relative to total ichthyoplankton biomass; therefore, measurable changes to fish recruitment would not occur.

AUV movement associated with the Proposed Action would not result in significant impacts to fish or result in significant harm to fish. Pursuant to the ESA, AUV movement associated with the Proposed Action would have no effect on ESA-listed fish species because are no ESA-listed fish where AUVs would be deployed. The Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat for ESA-listed fish as it is located outside of the proposed action areas.

4.2.3.1.c Seabirds and Shorebirds

The potential for a bird strike by either the AUV is low, given the limited amount of time seabirds spend in the water relative to the air. In the unlikely event that a seabird encounters the AUV, the risk of a strike is extremely low. In the extremely rare instance that an AUV and seabird collision occurs, no long-term or population level effects are expected.

AUV movement associated with the Proposed Action would not result in significant impacts to birds or result in significant harm to birds. Pursuant to the ESA, AUV movement associated with the Proposed Action may affect, but is not likely to adversely affect the ESA-listed short-tailed albatross, Steller's eider, and spectacled eider. AUV movement would not alter any resources essential to the conservation of ESA-listed seabirds, such as physical features of the marine waters or prey items. The Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat of the spectacled or Steller's eider. There would be no effect to ESA-listed marbled murrelets from AUVs as they are located outside of the area where ice reconnaissance would occur. Pursuant to the MBTA, in-water device movement associated with the Proposed Action would not result in a significant adverse effect on migratory bird populations.

4.2.3.1.d Marine Mammals

The potential for a marine mammal to be struck by an AUV is similar to that identified for vessels. Physical disturbance from the use of AUVs is not expected to result in more than a momentary behavioral response. The risk of a collision between an AUVs moving through the water and a marine mammal is low. However, the implementation of the Coast Guard's SOPs BMPs (see Chapter 6) would reduce the likelihood of collision. While several species of marine mammals could be encountered in the proposed action areas where AUVs would be deployed, missions in which AUVs are deployed would not take place close to barrier islands or terrestrial denning habitat for polar bears. Any change to an individual's behavior from AUV is not expected to result in long-term or population level effects.

AUV movement from the Proposed Action is not likely to significantly impact marine mammals or result in significant harm marine mammals. AUV use by the Coast Guard would only be for ice reconnaissance. Pursuant to the ESA, AUV movement would have no effect on the blue whale, fin whale, gray whale, humpback whale, North Pacific right whale, sei whale, Southern Resident killer whale, sperm whale, and Steller sea lion. Pursuant to the ESA, AUV movement may affect, but is not likely to adversely affect bowhead whales, polar bears, bearded seals, and ringed seals. AUV movement would not overlap critical habitat for the Southern Resident killer whale or Steller sea lion. AUV movement associated with the Proposed Action would not alter primary copepod prey species essential to the conservation of ESA-listed North Pacific right whales or the sea ice habitat and primary prey species essential to the conservation of ESA-listed ringed seals.The Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat for the North Pacific right whale, Southern Resident killer whale, Steller sea lion, or the proposed ringed seal critical habitat.

4.2.3.1.e Impacts from Collision from AUV Movement Under the Alternatives 2 and 3

Alternative 2: Leasing

It is assumed that AUV movement from a leased vessel would be similar to what is in current use and the potential impact would be similar to what was analyzed under Alternative 1. Therefore, the potential impacts associated with AUV movement under Alternative 2 are the same as under Alternative 1. Therefore, AUV movement from Alternative 2 is not likely to significantly impact or result in significant harm to invertebrates, fish, birds, and marine mammals.

Alternative 3: No Action

Under the No Action Alternative, the Coast Guard would fulfill its missions in the Arctic and Antarctic using existing polar icebreaker assets, which are reaching the end of their service lives. The current polar icebreaker fleet would continue current operations. Therefore, as long as the current polar icebreaker fleet is operational, baseline conditions of the existing environment would remain unchanged and would not significantly impact or result in significant harm to invertebrates, fish, birds, and marine mammals. Once the current fleet of icebreakers are decommissioned and no longer in operation, the Coast Guard would no longer have polar icebreakers in their fleet and therefore, operations and training from a polar icebreaker would no longer occur.

4.2.4 Icebreaking

Icebreaking would occur in the Arctic and Antarctic proposed action areas at speeds of 3 to 6 knots. Icebreaking has the potential to impact or harm marine species by altering habitats, causing behavior reactions, or leading to strike of an animal. The general movement of the icebreaker vessel is analyzed previously as part of vessel movement in Section 4.2.1 and icebreaking noise in Section 4.1.4.

In late June, the total sea ice extent is around 3.9 million mi^2 (10 million km^2) in the Arctic. An icebreaker cruising through the ice for 620 mi (1,000 km) would open an area of water 3.9 mi^2 (10 km^2) over the entire cruise (Meier 2012). In contrast, the Arctic sea ice cover decreases by an average of over 3.5 million mi^2 (9 million km^2) each year during the melt season (Meier 2012). Based on the above estimation, the actual contribution of icebreaking to sea ice reduction is only one part in a million of the total ice cover. Therefore, this will not be discussed further in this section.

It is not anticipated that icebreaking would impact or harm marine vegetation (see Section 3.2.1). Marine vegetation living under ice may encounter short-term and localized disturbances from icebreaking, including limited mortality. However, no long-term or population level effects are expected as the amount of biomass that would potentially be impacted or harmed is insignificant relative to the overall biomass of the system. There would be no impacts to sea turtles as they are not found in the icebreaking areas. Therefore, they will not be further discussed. A summary of the impact or harm to fish, EFH, seabirds, and marine mammals is provided in detail below.

4.2.4.1 Invertebrates

The population of invertebrates with the most potential for impact or harm from icebreaking associated with the Proposed Action are the sympagic invertebrates that live on or in the ice in both the Arctic and Antarctic proposed action areas (Guglielmo et al. 2000; Kohlbach et al. 2016; Kramer et al. 2011). Individuals of these species could be killed or displaced by the impact of icebreaking. Because the impact would be localized to the immediate path of the vessel, icebreaking disturbance would not be expected to have an impact on the vast majority of the biomass of sympagic invertebrates and therefore, no population level impacts would be expected. Though many other communities are also dependent on sympagic production (Kohlbach et al. 2016), the impact on those food web dynamics would be similarly small, since the ratio of affected area to unaffected area is extremely small.

Icebreaking disturbance associated with the Proposed Action would not result in significant impacts to invertebrates or result in significant harm to invertebrates. There are no ESA-listed invertebrates within the proposed action areas.

4.2.4.2 Fish

Many fish species associate with ice, such as arctic and polar cod to live or feed immediately under, or in cracks and fissures in the ice cover. Fish provide an important food source for many predators (e.g., penguins and seals) (Lønne and Gabrielsen 1992; Mecklenburg et al. 2013). The potential exists for these individuals to be injured, or displaced by icebreaking activities. A PIB would travel at 3 to 6 knots while icebreaking and may be even slower when breaking heavy ice; therefore, fish would be expected to exhibit a behavioral response such as avoidance, escape or startle. Furthermore, since the impact would be limited only to the area directly in the path of the icebreaking vessel, the portion of the overall population that would be impacted would be extremely small, and no population level effects would be anticipated.

Icebreaking disturbance associated with the Proposed Action would not result in significant impacts to fish or result in significant harm to fish. There are no ESA-listed fish species in proposed action areas where icebreaking would occur. Therefore, there would be no effect to ESA-listed bocaccio, Chinook salmon, chum salmon, coho salmon, Pacific eulachon, sockeye salmon, steelhead trout, and yelloweye rockfish anticipated from icebreaking activities as part of the Proposed Action. The Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat for ESA-listed fish as it is located outside of the proposed action areas.

4.2.4.3 Essential Fish Habitat

EFH has been established for late juvenile and adult Arctic cod as distribution areas for this life stage located in pelagic and epipelagic waters from the nearshore to offshore areas along the entire shelf (0 to 656 ft [0 to 200 m]) and upper slope (656 ft to 1,640 ft [200 to 500 m]) throughout Arctic waters and often associated with ice floes, which may occur in deeper waters. Icebreaking may result in localized changes to Arctic cod's EFH Essential Fish Habitat as larger sheets of floating ice are broken down into smaller sizes. However, icebreaking is not expected to significantly alter Arctic cod ice floe habitat. Pursuant to the Magnuson-Stevens Act, an action may adversely affect EFH when it may reduce the quantity or quality of EFH, because it could be meaningfully measured or observed individually or cumulatively (regardless of duration or scale), or is likely to occur. Icebreaking associated with the Proposed Action may affect the quality or quantity of Arctic cod EFH. However, the effects of icebreaking on Arctic cod EFH would be minimal, due to the small area of icebreaking as compared to the overall quantity of ice floe habitat. Therefore, icebreaking associated with the Proposed Action would not result in significant impact or result in significant harm to EFH.

4.2.4.4 Seabirds and Shorebirds

Certain birds are known to associate with ice in the proposed action area, including emperor penguins, Adélie penguins, ivory gulls, thick-billed murres, king eider, spectacled eider, and other species of gulls, terns, and auks. These birds use the ice as a platform for resting and in some cases feeding. ESA-listed spectacled eiders use the ice as a platform for resting and feed along the ice edge. Emperor penguins also use sea ice for breeding. The icebreaker would be expected to travel at 3 to 6 knots while breaking ice, and therefore, it is expected that seabirds would detect the icebreaker and avoid the icebreaker's path before it overlaps with their resting or feeding areas. Thus, only temporary behavioral responses are expected. In the extremely rare event that an individual is killed or injured by icebreaking; it would not be expected to have any population level impact.

Penguins are more susceptible to icebreaking than other bird species in the proposed action areas due to their close association with sea ice and reduced mobility while out of the water. The penguin species observed in the Ross Sea are Adélie and emperor penguins. Adélie penguins breed on land, and emperor penguins breed on sea ice in the austral autumn. Neither species would be exposed to icebreaking operations which occur during the austral summer.

The long-term effect of icebreaking activities on seabirds is expected to be negligible because any response is expected to be temporary and any seabird that did exhibit a behavioral response would be expected to return to its normal behavior once icebreaking has ceased or the icebreaker has left the area. Icebreaking associated with the Proposed Action would not alter the physical or biological features essential to the conservation of ESA-listed spectacled or Steller's eiders. Seabirds are either not likely to respond to icebreaking or are not likely to respond in ways that would significantly disrupt normal behavior patterns which include, but are not limited to: migration, breeding, feeding, or sheltering. Ice habitats are not designated as essential elements of critical habitat for Steller's or spectacled eider.

Icebreaking associated with the Proposed Action would not result in significant impacts to birds or result in significant harm to birds. Pursuant to the ESA, icebreaking associated with the Proposed Action may affect, but is not likely to adversely affect the ESA-listed spectacled eider nor would it result in the destruction or adverse modification of federally-designated critical habitat of the spectacled eider or Steller's eider. Icebreaking would have no effect on the ESA-listed marbled murrelet, short-tailed albatross, or Steller's eider as they do not associate with sea ice. Pursuant to the MBTA, icebreaking associated with the Proposed Action would not result in a significant adverse effect on migratory bird populations.

4.2.4.5 Marine Mammals

As discussed in Section 4.1.4.4, the noise associated with icebreaking activities is most likely to result in marine mammals swimming away from the icebreaking vessel or avoiding the area for a short period. Therefore, it is highly unlikely that icebreaking would strike a marine mammal or cause any physical harm. Pinnipeds and polar bears that haul out on the ice may be more susceptible to impacts caused by icebreaking.

The proposed critical habitat for ringed seals includes the following essential features:

- Sea ice habitat suitable for the formation and maintenance of subnivean birth lairs used for sheltering pups during whelping and nursing.
- Sea ice habitat suitable as a platform for basking and molting, which is defined as sea ice of 15 percent or more concentration, except for bottom-fast ice extending seaward from the coastline in waters less than 6.6 ft (2 m) deep.
- Primary prey resources to support Arctic ringed seals, which are defined to be arctic cod, saffron cod, shrimp, and amphipods.

Critical habitat for polar bears includes the following essential features, relative to sea ice:

- Sea ice habitat located over the continental shelf at depths of 984 ft (300 m) or less. In spring and summer, this habitat follows the northward progression of the ice edge as it retreats northward. In fall, this sea ice habitat follows the southward progression of the ice edge as it advances southward.
- Sea ice within 1 mi (1.6 km) of the mean high tide line of barrier island habitat. Barrier islands are used as migration corridors. Polar bears can move freely between barrier islands by swimming or walking on ice or sand bars, thereby avoiding human disturbance.

Though no critical habitat is designated for bearded seals, they are also strongly associated with sea ice habitat in the Arctic. In winter, individuals generally move south as the pack ice advances into the Bering Sea. In late spring and summer, bearded seals move north as the ice edge recedes into the Chukchi and Beaufort seas. However, some bearded seals stay near the edge of shorefast ice all winter and do not migrate south. Leads, polynyas, and other openings in the sea ice are important features of bearded seal habitat. Juvenile bearded seals tend to associate with sea ice less than adults and are often found in ice free areas such as bays and estuaries. The distribution of bearded seals appears to be strongly associated with shallow water and high biomass of the benthic prey they feed on. They are limited to feeding depths of less than 492-656 ft (150–200 m).

Icebreaking activities would be limited to areas of thick, wide concentrations of sea ice. Although icebreaking may result in the temporary displacement of primary prey resources of ringed seals, these species are expected to return to their normal behaviors shortly after the initial disturbance. In the spring through the fall, these areas are expected to be at a minimum, which would reduce the impact to the ringed seals' proposed critical habitat. The ringed seal subnivean lairs are excavated in drifts over 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 (Smith and Stirling 1975). Most ringed seals are born in early April and about a month after parturition, mating begins in late April and early May. Ringed seals are expected in the Arctic proposed action area year-round, but during the Arctic summer months, from May to September, pupping will not occur and subnivean lairs will not be occupied. Since icebreaking may occur year-round, especially with the reduction in ice extent and accessibility needs of users in the Arctic Region, icebreaking areas could overlap with subnivean lairs. However, Williams et al. (2006) determined that ringed seals abandoned subnivean lairs in areas where there was high ice deformation. In addition, ringed seals appeared to abandon and construct structures in the Beaufort Sea throughout the winter and spring at rates higher than previously documented; in particular, more structures are created as the season progressed (Williams et al. 2006). This supports the concept that ringed seals have a non-exclusive reliance on early winter structures.

Ringed seals typically construct their lairs in landfast ice (ice securely attached to land) that typically extends 25 to 40 km offshore (Kovacs and Mellor 1974; Stringer 1974; Wadhams 2000). Williams et al. (2006) indicated that given the turnover and creation of new structures during the ice-covered season, it is unlikely that the loss of a breathing hole or resting structure over the course of the winter, from natural or anthropogenic causes, would significantly impact an individual seal. Although icebreaking could overlap with ringed seal structures, it is likely that the noise of the icebreaking would alert any seal well before the icebreaker reaches the subnivean lair, and similar to a predator flight response, the seal would abandon the lair. Therefore, it is unlikely that icebreaking would cause injury or mortality to a ringed seal or their pup from the physical presence of the icebreaking.

Icebreaking may result in localized changes to the polar bear and proposed ringed seal critical habitat as larger sheets of floating ice are broken down into smaller sizes. However, icebreakers do not diminish or destroy ice habitat because the amount of ice that is broken up relative to the overall total amount of ice is small.

Icebreaking from the Proposed Action is not likely to significantly impact marine mammals or result in significant harm to marine mammals. Pursuant to the ESA, icebreaking would have no effect on the blue whale, fin whale, gray whale, humpback whale, North Pacific right whale, sei whale, Southern Resident killer whale, sperm whale, and Steller sea lion. In accordance with the ESA, icebreaking may affect, but is not likely to adversely affect bowhead whales, polar bears, bearded seals, and ringed seals. The

Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat for the North Pacific right whale, Southern Resident killer whale, Steller sea lion, polar bear, and the proposed ringed seal critical habitat because critical habitat would be avoided.

4.2.4.6 Impacts from Icebreaking Under the Alternatives 2 and 3

Alternative 2: Leasing

It is assumed that icebreaking from a leased vessel would be similar to what is in current use and the potential impact would be similar to what was analyzed under Alternative 1. Therefore, the potential impacts associated with icebreaking under Alternative 2 are the same as under Alternative 1. Therefore, icebreaking from Alternative 2 is not likely to significantly impact or result in significant harm to invertebrates, fish, EFH, birds, and marine mammals.

Alternative 3: No Action

Under the No Action Alternative, the Coast Guard would fulfill its missions in the Arctic and Antarctic using existing polar icebreaker assets, which are reaching the end of their service lives. The current polar icebreaker fleet would continue current operations. Therefore, as long as the current polar icebreaker fleet is operational, baseline conditions of the existing environment would remain unchanged and would not significantly impact or result in significant harm to invertebrates, fish, EFH, birds, and marine mammals. Once the current fleet of icebreakers are decommissioned and no longer in operation, the Coast Guard would no longer have polar icebreakers in their fleet and therefore, operations and training from a polar icebreaker would no longer occur.

4.2.5 Military Expended Materials

As part of the Proposed Action, defensive and offensive gunnery training activities would occur in open ocean locations in the Pacific Northwest proposed action area and on rare occasions in the Arctic proposed action area (see Section 2.1.1). MEM associated with these activities would include targets, target fragments, and inert small caliber projectiles[13] that would not be recovered. Targets used as part of the Proposed Action are surface "killer tomato" units, which are designed for reuse, however retrieval would not be expected during Proposed Action. Additionally, high-explosives would not be used for training purposes and gunnery training would not likely produce target fragments. Most likely, these targets would drift with currents until popping, then sink through the water column and end up on the seafloor. Targets placed on ice (in the Arctic proposed action area) would sink once the ice melts. As target sink to the seafloor, they would be degraded over time. Marine microbes and fungi, such as polyhydroxyalkanoates, a bacterial carbon and energy source, are known to degrade biologically produced polyesters (Doi et al. 1992). Marine microbes also degrade other synthetic polymers, although at slower rates (Shah et al. 2008).

[13] Specifically, military munitions as they relate to solid waste and their intended use, are not discarded, not solid wastes under RCRA's Subtitle C regulations, and consequently not regulated as hazardous waste. The EPA seeks to avoid interference with DoD's national security mission regarding training and readiness. Therefore, EPA's practice is to exercise its enforcement discretion to except from RCRA regulation MEC used for its intended purpose and remaining on operational ranges. However, EPA has used the Agency's remedial cleanup enforcement authorities' environment at operational ranges when necessary to ensure protection of public health and the environment.

Inert small caliber (0.50 caliber or MK-38 standard [25 mm]) gun rounds used in gunnery training may also enter the water as MEM during the Proposed Action and would not be recovered. These small caliber projectiles may be ingested by species on the seafloor, which is analyzed below.

MEM have the potential to impact or harm the marine environment by altering or disturbing the seafloor. Target, target fragments, and small caliber gun rounds may impact or harm individual animals, but the number of individuals that could be impacted or harmed would be few, such that it would not result in significant population level effects. It is not anticipated that MEM would impact or harm marine vegetation (see Section 3.2.1), because the likelihood that MEM would overlap with marine vegetation in the proposed action areas is extremely rare. Due to their size, such MEM would not be expected to impact or harm invertebrates. No effect to leatherback sea turtles is anticipated as MEM would not overlap with the leatherback sea turtle's range. The potential impact or harm from MEM to bottom habitats and sediments and EFH, as well as potential impact or harm from ingestion of MEM by fish, birds and marine mammals is discussed in detail below.

4.2.5.1 Bottom Habitat and Sediments

Small caliber projectiles are metal and would move quickly through the water column before settling on the bottom habitat and sediments in the proposed actions areas (see Section 3.1.1). Settling (MEM) on the seafloor could impact marine habitats by creating localized disturbance of the seafloor, craters of soft bottom sediments, or structural damage to hard bottom habitats. Impacts on soft bottom habitats would be short term, as these are constantly moving and shifting. Impacts on hard bottom would be long term. It is anticipated that, over time, projectiles could become colonized by invertebrates, thus, becoming part of the bottom habitat. MEM that settles in the shallower, more dynamic environments of the continental shelf would likely be covered over by sediments due to currents and other coastal processes. After many years the materials that make up MEM would break down into smaller pieces and become part of the sediment. MEM associated with the Proposed Action would not result in significant impacts or harm to the bottom habitat and sediments in the proposed action areas.

4.2.5.2 Essential Fish Habitat

In both the Pacific Northwest and Arctic proposed action areas (Bering Sea), many species of fish have bottom habitat designated as EFH. These are discussed in Section 3.2.4.2 and Section 3.2.4.1, respectively. Gunnery training would take place either in the Pacific Northwest proposed action area or on an existing Navy range. MEM from gunnery training consists of 500 small caliber rounds per year. MEM impacts on soft bottom habitats, which comprise most of this area, would be short term, as sediments are constantly moving and shifting. Pursuant to the EFH requirements of the Magnuson-Stevens Act and implementing regulations, the use of MEM during gunnery training would not have an adverse effect on EFH because the quality and quantity of non-living substrate that constitutes EFH would not be reduced due to the small amount of expended materials.

4.2.5.3 Fish

Gunnery training for which killer tomato targets are used would primarily take place in the Pacific Northwest proposed action area, and on rare occasions in the Arctic (Bering Sea). Fish species for these areas are explained in greater detail in Sections 3.2.3.3and 3.2.3.1, respectively. MEM from targets would not present a significant threat to fish populations because of the small numbers of these targets used and the large distance which expended material would be dispersed across the proposed action areas. Small pieces may be ingested by an individual, however targets and target fragments left as expended material are not in high enough densities to cause population level impacts to fish.

Small caliber practice munitions travel quickly through the water column and settle on the seafloor. Thus, the potential for ingestion risk is present for fish species that feed on the seafloor and in relatively deep waters where gunnery training would occur. Bottom-dwelling predators could ingest these settled projectiles from the seafloor. It is also possible that settled projectiles would be colonized by seafloor organisms, mistaken for prey, and accidentally or intentionally eaten during foraging. The metal of the munitions corrodes slowly or may become covered by sediment in some habitats, reducing the likelihood that a fish would encounter them. The potential for fish species to encounter and ingest expended projectiles is evaluated with respect to their feeding group and geographic range, which influence the probability that they would eat small projectiles. As there are no bottom-dwelling ESA-listed species that occur at the offshore locations where small caliber projectiles would be expended, the potential does not exist for ESA-listed fish species to ingest these items.

MEM associated with the Proposed Action would not result in significant impacts or result in significant harm to fish. Pursuant to the ESA, ingestion of MEM associated with the Proposed Action would have no effect on ESA-listed bocaccio, Chinook salmon, chum salmon, coho salmon, Pacific eulachon, sockeye salmon, steelhead trout, or yelloweye rockfish, as the potential of ingestion overlapping with the species' presence are discountable or insignificant. Pursuant to the ESA, MEM associated with the Proposed Action may affect, but is not likely to adversely affect the ESA-listed bocaccio, Chinook salmon, chum salmon, coho salmon, Pacific eulachon, sockeye salmon, steelhead trout, or yelloweye rockfish. The Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat for ESA-listed fish as it is located outside of the proposed action areas.

4.2.5.4 Seabirds and Shorebirds

Gunnery training would take place in the Pacific Northwest proposed action area, rare and unlikely in the Arctic proposed action area. This proposed action area only overlaps with the range of presence for the ESA-listed marbled murrelet, in addition to other non-ESA listed species. Because of the small numbers of these targets, and due to the distance at which they would be dispersed across the proposed action areas, target (e.g., killer tomato) and target fragments would not present a significant threat to seabird populations. Gunnery training would not be conducted inshore where the majority of bird species inhabit, including the ESA-listed marbled murrelet. Physiological harm to birds from ingesting small caliber munitions generally includes blocked digestive tracts and subsequent food passage, blockage of digestive enzymes, lowered steroid hormone levels, delayed ovulation (egg maturation), reproductive failure, nutrient dilution (nonnutritive debris displaces nutritious food in the gut), and altered appetite satiation (the sensation of feeling full), which can lead to starvation (Azzarello and Vleet 1987). While ingestion of marine debris has been linked to bird mortalities, non-lethal harm is more common (Moser and Lee 1992).

Gunnery training exercises would not take place in any area designated as critical habitat, nor would it take place in the Arctic where critical habitats for the ESA-listed spectacled eider and Steller's eider are located. Seabirds and shorebirds of the proposed actions areas are discussed in greater detail in Section 3.2.5.

MEM associated with the Proposed Action would not result in significant impacts to birds or result in significant harm to birds. Pursuant to the ESA, MEM associated with the Proposed Action may affect, but is not likely to adversely affect the ESA-listed marbled murrelet. Pursuant to the ESA, there would be no effect to the ESA-listed short-tailed albatross, spectacled eider, or Steller's eider from MEM associated with the Proposed Action. MEM associated with the Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat of the spectacled or Steller's eider. Pursuant to the MBTA, MEM associated with the Proposed Action would not result in a significant adverse effect on migratory bird populations.

4.2.5.5 Marine Mammals

Marine mammals found within the proposed actions areas are discussed in more detail in Section 3.2.7.3 (Pacific Northwest) and Section 3.2.7.1 (Arctic). Most marine mammals feed either at the surface or in the water column. MEM has the potential to impact or harm marine mammal species that feed on the bottom.

Of the mysticetes, gray whales regularly feed at the seafloor, but do so in relatively shallow water soft sediment seafloor area where MEM from the Proposed Action is likely to be present. While humpback whales feed predominantly by lunging through the water after krill and fish, there are instances of humpback whales disturbing the bottom in an attempt to flush prey, such as sand lance (Hain et al. 1995). In a comprehensive review of documented ingestion of debris by marine mammals, there are two species of mysticetes (bowhead and minke whale) with ingestion records (Laist 1997). The items ingested included plastic sheeting and a polythene bag (Laist 1997), both found typically within the water column. Since gray whales and humpback whales are known to forage at the seafloor, it is possible, but extremely unlikely that they would ingest items found on the seafloor.

Of the odontocetes, sperm whales are known to incidentally ingest foreign objects while foraging; however, this does not always result in negative consequences to health or vitality (Laist 1997; Walker and Coe 1989). While this incidental ingestion has led to sperm whale mortality in some cases, Whitehead (Whitehead 2002) suggests the scale to which this affects sperm whale populations is not significant. Sperm whales are recorded as having ingested fishing net scraps, rope, wood, and plastic debris such as plastic bags and items from the seafloor (Walker and Coe 1989). Walker and Coe (Walker and Coe 1989) provided data on the stomach contents from of 16 species of odontocetes, some of which occur or had stranded in North Pacific waters, with evidence of debris ingestion. Of the odontocete species occurring in the proposed action area, only sperm whales have been documented have ingested items (likely incidentally) that do not float and are thus indicative of foraging at the seafloor. Based on the available evidence, since sperm whales are known to forage at the seafloor, it is possible but unlikely that sperm whales would ingest items found on the seafloor.

Most of the pinniped species feed within the water column and on the seafloor. In a comprehensive review of documented ingestion of debris by marine mammals, there is only one ESA-listed pinniped species found within the proposed action area. A Steller sea lion ingestion record documents ingestion of a Styrofoam cup (Laist 1997), an object which floats and can be found mainly in the water column where this species feeds. As pinnipeds mainly feed at or below the water's surface in the water column, and not on the seafloor, expended practice munitions are not likely to be encountered or ingested by pinnipeds as they move quickly through the water column and therefore, no impact or harm to pinnipeds is expected.

Ingestion associated with the Proposed Action would not result in significant impacts to marine mammals or result in significant harm to marine mammals. Pursuant to the ESA, ingestion associated with the Proposed Action would have no effect on the ESA-listed blue whale, bowhead whale, fin whale, North Pacific right whale, Southern Resident killer whale, sei whale, bearded seal, ringed seal, or Steller sea lion. Pursuant to the ESA, ingestion associated with the Proposed Action may affect, but is not likely to adversely affect the gray whales, humpback whales, and sperm whales. Therefore, pursuant to the ESA, ingestion associated with the Proposed Action will have no effect on ESA-listed species. Additionally, there would be no effect to polar bears from MEM as the range of this species does not overlap with the area in which gunnery training would occur. MEM would not overlap designated critical habitat for the polar bear, Southern Resident killer whale, Steller sea lion, or ringed seal. MEM associated with the Proposed Action would not alter primary copepod prey species essential to the conservation of ESA-listed North Pacific right whales or the sea ice habitat and primary prey species essential to the conservation of ESA-listed ringed seals. MEM would not result in the destruction or adverse modification of federally-designated critical habitat for the North Pacific right whale, Southern Resident killer whale, Steller sea lion, polar bear, or ringed seal.

4.2.5.6 Impacts from Military Expended Materials Under the Alternatives 2 and 3

Alternative 2: Leasing

It is assumed that MEM associated with gunnery training from a leased vessel would be similar to what is in current use and the potential impact would be similar to what was analyzed under Alternative 1. Therefore, the potential impacts associated with AUV movement under Alternative 2 are the same as under Alternative 1. Therefore, MEM from Alternative 2 is not likely to significantly impact or result in significant harm to bottom habitat and sediments, EFH, invertebrates, fish, birds, and marine mammals.

Alternative 3: No Action

Under the No Action Alternative, the Coast Guard would fulfill its missions in the Arctic and Antarctic using existing polar icebreaker assets, which are reaching the end of their service lives. The current polar icebreaker fleet would continue current operations. Therefore, as long as the current polar icebreaker fleet is operational, baseline conditions of the existing environment would remain unchanged and would not significantly impact or result in significant harm to bottom habitat and sediments, EFH, invertebrates, fish, birds, and marine mammals. Once the current fleet of icebreakers are decommissioned and no longer in operation, the Coast Guard would no longer have polar icebreakers in their fleet and therefore, operations and training from a polar icebreaker would no longer occur.

4.2.6 Summary of Impacts from Physical Stressors

Vessels and aircraft associated with the Proposed Action are widely dispersed throughout the proposed action areas. The physical presence of aircraft and vessels could lead to behavioral reactions from visual or auditory cues. The disturbance from vessels or aircraft associated with the Proposed Action are expected to result in, at most, minor to moderate avoidance responses of a few animals, over short and intermittent periods of time. The long-term effect of the Proposed Action's activities is expected to be negligible because any response is expected to be temporary and any individual animal exhibiting a behavioral response would be expected to return to normal behavior once the stimulus is gone. The Proposed Action is not expected to cause significant behavioral disruptions, such as stampedes at haulout sites, or abandonment of breeding, that would result in significantly altered or abandoned behavior patterns. Marine species are either not likely to respond to the presence of vessels or aircraft or are not likely to respond in ways that would significantly disrupt normal behavior patterns which include, but are not limited to: migration, breeding, feeding, or sheltering. In the analysis of physical stressors, it was concluded there would be no significant impact or harm to the physical, biological, or socioeconomic environment, including marine vegetation, invertebrates, fish, EFH, birds, sea turtles, marine mammals, and socioeconomic resources.

Additionally, the Proposed Action would not alter the physical or biological features essential to the conservation of ESA-listed species. The Coast Guard's SOPs and BMPs, as described in Chapter 6, are in place to avoid close approaches to visible protected species and habitats. The Coast Guard will post lookouts to alert vessels when a protected species is sighted to try and avoid areas where ESA-listed species are commonly observed, which is expected to decrease the likelihood of close approach to these species. Physical stressors from the Proposed Action would not cause population level effects to any ESA-listed species in the proposed action areas.

4.2.6.1 Summary of Impacts to Species from Physical Stressors

As described above, the physical sources in the Proposed Action are expected to result in, at most, minor to moderate behavioral responses over short and intermittent periods of time. Vessel movement, aircraft movement, AUV movement, icebreaking, and military expended materials associated with the Proposed Action would not result in significant impact or result in significant harm to invertebrates, fish, birds, sea turtles, and marine mammals. ESA-listed species would not be expected to respond in ways that would significantly disrupt normal behavior patterns which include, but are not limited to: migration, breathing, nursing, breeding, feeding or sheltering. Physical stressors from the Proposed Action would not cause population level effects to any ESA-listed species in the proposed action areas.

4.2.6.2 Summary of Impacts to Critical Habitat from Physical Stressors

As described above, the Coast Guard will avoid all known critical habitat areas (see Chapter 6). Pursuant to the ESA, vessel movement, aircraft movement, AUV movement, icebreaking, and military expended materials associated with the Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat of the Steller's eider, spectacled eider, North Pacific right whale, polar bear, Southern Resident killer whale, Steller sea lion, or proposed ring seal critical habitat. No other critical habitat overlaps the proposed action areas; therefore, there will be no effect to critical habitat outside of the Arctic and Pacific Northwest proposed action areas.

4.2.6.3 Summary of Impacts from Physical Stressors Under the Alternatives 2 and 3

Alternative 2: Leasing

It is assumed that vessel movement, aircraft movement, AUV movement, icebreaking, and military expended materials associated with Alternative 2 would be similar to what is in current use and the potential impact would be similar to what was analyzed under Alternative 1. Therefore, the potential impacts associated with these stressors under Alternative 2 are the same as under Alternative 1. Therefore, vessel movement, aircraft movement, AUV movement, icebreaking, and military expended materials associated with Alternative 2 are not likely to significantly impact or result in significant harm to invertebrates, fish, EFH, birds, sea turtles, or marine mammals.

Alternative 3: No Action

Under the No Action Alternative, the Coast Guard would fulfill its missions in the Arctic and Antarctic using existing polar icebreaker assets, which are reaching the end of their service lives. The current polar icebreaker fleet would continue current operations. Therefore, as long as the current polar icebreaker fleet is operational and includes air support, baseline conditions of the existing environment would remain unchanged and would not significantly impact or result in significant harm invertebrates, fish, EFH, seabirds, sea turtles, and marine mammals. Once the current fleet of icebreakers are decommissioned and no longer in operation, there would be no impact or harm from these vessels or the aircraft and small vessel support associated with the icebreakers.

4.3 Socioeconomic Impacts

Commercial fishing, recreational fishing, research, transportation and shipping, tourism, and subsistence hunting and cultural resources are the socioeconomic resources that would be impacted by the Proposed Action. The predominant socioeconomic impact of the PIB program would be an increased Coast Guard presence in the proposed action areas and the Coast Guard's jurisdictional areas. Replacement of the ageing Coast Guard's polar icebreaker fleet would facilitate the Coast Guard's ability to support the Coast Guard mission including law enforcement, provide consistent search and rescue capabilities, and support on-going research operations. An increase in the Coast Guard icebreaking fleet would be beneficial, and any potential negative impacts caused by the Coast Guard's presence and operations and training, would be mitigated by the implementation of SOPs and BMPs (see Chapter 6). Additionally, outreach and educational programs conducted by the Coast Guard within the proposed action areas would facilitate communication between Coast Guard and the communities that they serve.

More readily available Coast Guard support during an at-sea emergency is the principal benefit of the Proposed Action to commercial fishing, recreational fishing, transportation and shipping, tourism, and cultural resources and the communities that depend on them. In the Pacific Northwest, the Coast Guard has worked with the Olympic Coast National Marine Sanctuary since 1994 to monitor ship traffic through Sanctuary waters and compile emergency plans. Together, they created an "Area to be Avoided (ATBA)" within the Sanctuary to limit traffic. Sanctuary and Coast Guard personnel educate shippers and seek voluntary compliance with the ATBA. As there has been a marked increase in vessel traffic in the polar regions, consistent and reliable response is paramount to Coast Guard mission success. While research conducted in both polar regions is supported by polar icebreakers, the Proposed Action would be integral to the continued access and resupply of the McMurdo research station in Antarctica.

In the Arctic proposed action area, interruption to subsistence hunting activities is a concern for some tribal communities. However, as stated in the SOPs and BMPs (see Chapter 6), properly trained lookouts would be aboard all Coast Guard vessels. Training would include identification of areas to avoid, such as active or anticipated subsistence hunting activities as determined through community engagement and information. The Coast Guard would coordinate with tribal representatives about planned hunts. Federally recognized tribes in the geographic region of the Proposed Action would be invited to consult on proposed undertakings to address issues concerning Indian Tribal self-government, trust resources, and Indian Tribal treaty and other rights.

4.3.1 Socioeconomic Impacts Under the Alternatives 2 and 3

Alternative 2: Leasing

It is assumed that any socioeconomic impacts from a leased vessel would be similar to what is in current present and the potential impact would be similar to what was analyzed under Alternative 1. Therefore, the potential impacts to socioeconomic resources under Alternative 2 are the same as under Alternative

1. Therefore, activities associate with the Proposed Action that would be included under Alternative 2 are not likely to significantly impact or result in significant harm to socioeconomic resources.

Alternative 3: No Action

Under the No Action Alternative, the Coast Guard would fulfill its missions in the Arctic and Antarctic using existing polar icebreaker assets, which are reaching the end of their service lives. The current polar icebreaker fleet would continue current operations. Therefore, as long as the current polar icebreaker fleet is operational, baseline conditions of the existing environment would remain unchanged and would not significantly impact or result in significant harm to marine mammals. Once the current fleet of icebreakers are decommissioned and no longer in operation, there would be no impact or harm from these vessels. In addition, the continuation of current operations would provide fewer benefits due to the smaller size of the polar icebreaker fleet. The beneficial impacts of Coast Guard presence would be diminished due to a potential decrease Coast Guard support for an at-sea emergency, law enforcement, consistent search and rescue capabilities, and support on-going research operations.

4.4 Summary of Potential Impacts to Resource Areas

A summary of the potential impacts associated with Action Alternatives 1, 2, and the No Action Alternative are presented in Table 4-7.

Table 4-7. Summary of Potential Impacts to Resource Area(s)

Resource	Alternative 1	Alternative 2: Leasing	Alternative 3: No Action
Physical Environment			
Bottom Habitat and Sediment	Settling of MEM on the seafloor from gunnery training could impact marine habitats by creating localized disturbance of the seafloor, craters of soft bottom sediments, or structural damage to hard bottom habitats. MEM that settles in the shallower, more dynamic environments of the continental shelf would likely be covered over by sediments due to currents and other coastal processes. No significant impact or significant harm is expected in the Arctic or Pacific Northwest proposed action areas. There would be no impact or harm to bottom habitat or sediment in the Antarctic proposed action area because no gunnery training would occur there.		No change to environmental baseline[*].
Sea Ice	Potential impacts or harm to sea ice may occur in the Arctic or Antarctic proposed action areas. The Proposed Action may modify sea ice through icebreaking by creating open water paths through sea ice. However, relative to the amount of sea ice present, icebreakers impact a very small amount of change to ice cover (e.g., one part per million of the total ice cover[**]). Thus, icebreaking may result in localized changes to sea ice' however, icebreakers would not diminish or destroy ice habitat because the amount of ice that is broken up relative to the overall total amount of ice is small. No significant impact or significant harm to sea ice is expected in the Arctic or Antarctic proposed action areas. There would be no impact or harm to sea ice as in the Pacific Northwest proposed action area because sea ice is not present and no icebreaking would occur.		No change to environmental baseline[*].
Biological Environment			
Marine Vegetation	MEM may sink to the bottom during gunnery training, but any impacts to marine vegetation, if present, would be temporary. A PIB would also not set the anchor in areas where marine vegetation is likely to occur in the proposed action areas. No significant impacts or significant harm to marine vegetation is expected in all proposed action areas.		No change to environmental baseline[*].
Invertebrates	Vessel and icebreaking noise, if perceived by an invertebrate, would likely result in avoidance behavior or other short term temporary responses, but would not result in any population level impact or harm. Vessel and AUV movement have the potential to impact or harm marine invertebrates either by disturbing the water column or directly striking the organism, if it is present on or near the ice. Although unlikely, invertebrates could be killed or displaced during icebreaking. Because the impact would be localized to the immediate path of a PIB, icebreaking disturbance would not be expected to have population level impacts. Vessel noise, icebreaking noise, vessel movement, AUV movement, and icebreaking, would not result in significant impact or result in significant harm to invertebrates in all proposed action areas.		No change to environmental baseline[*].

Resource	Alternative 1	Alternative 2: Leasing	Alternative 3: No Action
Fish	Underwater acoustic transmissions, vessel noise, icebreaking noise, and icebreaking would likely result in short-term and insignificant behavioral reactions or avoidance behavior, and thus, would not be expected to have any population level impacts. AUV and vessel movement may result in short-term and local displacement of fish in the water column. Although unlikely, small pieces of MEM from gunnery training and small caliber practice munitions may be ingested by an individual. Vessel noise, icebreaking noise, vessel movement, AUV movement, icebreaking, and MEM, would not result in significant impacts or significant harm to fish in all proposed action areas.		No change to environmental baseline*.
EFH	Acoustic transmissions could increase in ambient sound level; however, this potential reduction in the quality of the acoustic habitat would be localized and temporary. Icebreaking associated with the Proposed Action may affect the quality or quantity of Arctic cod EFH; however, the effects of icebreaking on Arctic cod EFH would be minimal, due to the small area of icebreaking as compared to the overall quantity of ice floe habitat. MEM impacts on soft bottom habitats would be short term, as sediments are constantly moving and shifting. Underwater acoustic transmissions, icebreaking, and MEM would not result in significant impact or significant harm to EFH in the Arctic and Pacific Northwest proposed action areas. No EFH is designated in the Antarctic proposed action area.		No change to environmental baseline*.
Seabirds	Vessel noise, icebreaking noise, vessel movement, and icebreaking would likely result in temporary behavioral responses. Any increase in ambient noise as a result of icebreaking or vessel movement would be temporary and localized to the position of the vessel as it transits or when icebreaking. Aircraft noise and gunnery noise may elicit, at most, short-term behavioral or physiological responses to exposed birds, such as an alert or startle response, or temporary increase in heart rate. While there is some risk of an aircraft-seabird strike, due to Coast Guard mitigation measures (e.g., limited duration of aerial operations); and avoidance of aircraft by seabirds, the risk of a strike is low. The potential for a bird strike by the AUV is extremely low, given the limited amount of time seabirds spend in the water relative to the air and low likelihood a diving seabird would overlap with AUV routes. Because of the small number of gunnery training targets, and the distance at which targets would be dispersed in the Arctic and Pacific Northwest proposed action areas, target and target fragments would not present a significant threat to seabird populations. Vessel noise, icebreaking noise, aircraft noise, gunnery noise, vessel movement, aircraft movement, AUV movement, icebreaking, and MEM would not result in significant impact or significant harm to seabirds.		No change to environmental baseline*.
Sea Turtles	Vessel noise in the open ocean may cause a startle response in sea turtles; however, any response is expected to be short term and temporary. Vessel noise from a PIB would not be		No change to environmental baseline*.

Resource	Alternative 1	Alternative 2: Leasing	Alternative 3: No Action
	expected to impact a sea turtle's ability to perceive other biologically relevant sounds. Although sea turtles would likely hear and see approaching vessels, a risk of a vessel collision with a sea turtle exists; however, sea turtles spend most of their time submerged, which would reduce their risk of a vessel collision. Vessel noise and vessel movement would not result in significant impact or result in significant harm to sea turtles in the Pacific Northwest proposed action area or in the Arctic proposed action area (although the leatherback sea turtle is considered extralimital). Aircraft movement, aircraft noise, icebreaking, and icebreaking noise would have no significant impact or significant harm on sea turtles as sea turtles would not overlap in areas where aircraft operations and icebreaking are expected.		
Marine Mammals	Acoustic transmissions and icebreaking noise, may result in minor to moderate behavioral responses to exposed individuals, but the behavioral response is expected to be temporary. Vessel noise may elicit a minor behavioral response by exposed individuals. Any noise generated by the unmanned aerial vehicle (UAV) is expected to be minimal and below the hearing threshold of marine mammals, both in air and underwater. The noise from the UAV is not expected to penetrate below the water's surface; however, in the unlikely event that a marine mammal is exposed to UAV noise underwater, any behavioral response is expected to be very minor. The probability of a vessel encountering a marine mammal is expected to be low, decreasing the risk of a PIB-marine mammal collision. The risk of a collision between an AUV moving through the water and a marine mammal is extremely low. It is expected that icebreaking noise would alert marine mammals to the presence of a PIB before icebreaking would overlap with a marine mammal. Therefore, due to the expected avoidance behaviors caused by icebreaking noise; the likelihood that a PIB would collide with a marine mammal during icebreaking is extremely low. Pinnipeds or polar bears that may be observed on the surface of the ice may be more susceptible to impacts caused by icebreaking, but avoidance responses are also expected, and SOPs and BMPs, such as trained Coast Guard lookouts, would minimize any potential impacts. During the Arctic summer months, from May to September, pupping would not occur and subnivean lairs would not be occupied. Icebreaking would only occur when needed and based on historical icebreaking, the majority occurs during the summer months. Therefore, the likelihood that a PIB would impact a subnivean lair is low. MEM has the potential to impact or harm marine mammal species that feed on the bottom, if ingested, but the likelihood that a marine mammal would ingest MEM is extremely low. The Proposed Action is not expected to cause abandonment of breeding or avoidance of breeding areas, disruption of migration or feeding, or significant disruption to pinniped haul outs. Underwater acoustic transmissions, vessel noise, icebreaking noise, aircraft noise, vessel movement, AUV movement, icebreaking, and MEM would not result in significant impact or significant harm to marine mammals.		No change to environmental baseline[*].

<table>
<tr><th>Resource</th><th>Alternative 1</th><th>Alternative 2: Leasing</th><th>Alternative 3: No Action</th></tr>
<tr><td colspan="4">Socioeconomic Environment</td></tr>
<tr><td>Commercial and Recreational Fishing,</td><td colspan="2">The Proposed Action would positively impact all the proposed action areas through Coast Guard law enforcement (e.g., illegal fishing), national security activities, and maritime safety/search and rescue. The Proposed Action would not result in significant negative impacts or significant harm to commercial or recreational fishing.</td><td>No change to environmental baseline*.</td></tr>
<tr><td>Research, Transportation, Shipping, and Tourism</td><td colspan="2">The Proposed Action would positively impact all the proposed action areas through Coast Guard law enforcement (e.g., unlawful activities), national security activities, maritime safety/search and rescue, and a platform for scientific research. The Proposed Action would not result in significant negative impacts or significant harm to research, transportation, shipping, and tourism.</td><td>No change to environmental baseline*.</td></tr>
<tr><td>Subsistence Hunting and Cultural Resources</td><td colspan="2">The Proposed Action would positively impact subsistence hunting in the Arctic and Pacific Northwest action areas by providing maritime safety/search and rescue, emergency response, and supporting educational opportunities. The Proposed Action would not result in significant negative impacts or significant harm to subsistence hunting. The Proposed Action would have no significant impact or significant harm on cultural resources in all proposed action areas as cultural resources would be avoided. No subsistence hunting occurs in the Antarctic.</td><td>No change to environmental baseline*.</td></tr>
</table>

*Once the current fleet of icebreakers operating in the polar regions are decommissioned and no longer in operation; under the No Action alternative, the Coast Guard would eventually be unable to conduct their missions in the polar regions without any icebreakers and therefore, icebreaker operations and training would no longer occur in the polar regions.

**National Snow and Ice Data Center, accessed July 2018: https://nside.org/cryosphere/icelights/2012/04/are-icebreakers-changing-climate

CHAPTER 5 CUMULATIVE IMPACTS

This section (1) defines cumulative impacts; (2) describes past, present, and reasonably foreseeable future actions relevant to cumulative impacts; (3) analyzes the incremental interaction the Proposed Action may have with other actions; and (4) evaluates cumulative impacts potentially resulting from these interactions. Mitigation measures proposed for avoiding or reducing impacts to resources are listed in Chapter 6. Additional mitigation measures may be considered based on consultations with regulatory agencies.

5.1 Definition of Cumulative Impacts

Cumulative impact, as defined by the CEQ, "results from the incremental impacts of [an] action when added to the other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7)."

5.2 Methodology for Assessing Cumulative Impacts

The analyses presented in this section place the direct and indirect impacts of PIB alternatives, presented in the preceding sections of Chapter 4, into a broader context that takes into account the full range of impacts of actions taking place within the Arctic, Antarctic, and Pacific Northwest proposed action areas, currently and into the reasonably foreseeable future. Repeated actions, even minor ones, may produce significant impacts over time through additive or interactive (synergistic) processes. The goal of the cumulative impacts assessment, therefore, is to identify such impacts early in the planning process to improve decisions and move toward more sustainable development (Council on Environmental Quality 1997).

The purpose of this analysis is to identify and describe cumulative impacts that would potentially result from the operations and training activities of PIBs. Inclusion of actions is based on identifying commonalities of impacts from other actions to the PIB project's potential impacts on various environmental resources. To ensure that the analysis focuses on relevant projects and potentially significant impacts, the cumulative impacts analysis presented in Section 5.4 incorporates the following basic guidelines:

- The individual resources identified in the affected environment sections of Chapter 3 become the endpoints or units of this analysis.
- Direct and indirect impacts of the Proposed Action (Alternative 1) and other action alternatives described in the Chapter 4 form the basis for the impact-producing factors considered.
- Impact-producing factors are derived from past, present and reasonably foreseeable future actions and trends.
- The spatial and temporal boundaries are defined around the individual resources and the set of past, present, and reasonably foreseeable future actions and trends that could impact them.

The cumulative impacts assessment focuses on the resources, ecosystems, and human communities that may be affected by the incremental impacts associated with the PIB (under any of the action alternatives) in combination with other past, present, and reasonably foreseeable future actions. The

CEQ discusses the assessment of cumulative impacts in detail in its 1997 report, Considering Cumulative Effects under NEPA (Council on Environmental Quality 1997). On the basis of the guidance provided in this report, the following methodology was developed for assessing cumulative impacts:

1. Potential cumulative impacts issues associated with the PIB (under any of the alternatives) were identified during the scoping and consultation phases of the assessment. Other actions and issues were added later as they were identified.
2. The spatial boundaries of cumulative impacts (i.e., regions of interest) were defined. The regions of interest encompass the geographic areas of affected resources, ecosystems, and human communities, and the distances at which impacts associated with the PIB and other past, present, and reasonably foreseeable future actions may occur. The spatial boundaries for the cumulative impacts assessment are discussed in Section 5.3.1.
3. The temporal boundaries (i.e., the time frame) of cumulative impacts were defined. The time frame of the cumulative impacts analysis extends from the past history of impacts on each resource through the anticipated life of each PIB and beyond. The temporal boundaries for the cumulative impacts assessment are discussed in Section 5.3.2.
4. Past, present, and reasonably foreseeable future actions were identified. These include projects and activities that could impact resources, ecosystems, or human communities within the defined regions of interest and within the defined time frame. Other processes and general trends (e.g., those associated with climate change) were also identified. Past and present actions are generally accounted for in the analysis of direct and indirect impacts under each resource area as part of the current baseline (described in Chapter 3) and are carried forward to the cumulative impacts analysis. The exploration and development scenarios for the PIB cumulative cases in the Arctic, Antarctic, and Pacific Northwest proposed action areas are presented in Section 5.4. The types of other past, present, and reasonably foreseeable future actions and general trends in in the Arctic, Antarctic, and Pacific Northwest proposed action areas are identified and described in Sections 5.4.1 through 5.4.13.
5. The potential impact-producing factors of past, present, and reasonably foreseeable future actions and general trends were determined. Impact-producing factors are the mechanisms by which an action or trend affects a given resource, ecosystem, or human community. The contributions of impact-producing factors from various actions and general trends were aggregated to form the contextual framework of the cumulative impact assessment to follow.
6. Cumulative impacts were evaluated by considering the incremental impacts of the Program (under any of the alternatives) in combination with other past, present, and reasonably foreseeable future actions and general trends. The cumulative impacts analyses for resources, ecosystems, and human communities are presented in Sections 5.4.1 through 5.4.13, and are summarized at the end of each section. Conclusions for resource and systems analyses in these sections are also provided.

For the purposes of this analysis, public documents prepared by federal, state, and local government agencies form the primary sources of information regarding reasonably foreseeable actions.

5.3 Scope of Cumulative Impacts Analysis

5.3.1 Spatial Boundaries

The spatial boundaries, i.e., regions of interest, for the cumulative impacts assessment encompass the geographic areas of affected resources and the distances at which impacts associated with past, present, and reasonably foreseeable future actions may occur. For the cumulative impacts analysis, marine and coastal ecoregions are used as the spatial framework for most resources because they encompass the areas potentially affected by the PIB and other (non-PIB) actions, both within and beyond the boundaries in which PIB activities would take place. The geographic scope of the cumulative analysis varies depending on the resource being evaluated, but concentrates in the Antarctic, Arctic, and Pacific Northwest proposed action areas, spanning the broadest possible geographic area and the extent of potential impacts.

5.3.2 Temporal Boundaries

The cumulative impacts analysis incorporates the sum of the effects of the Program in combination with other past, present, and future actions, since impacts may accumulate or develop over time. The future actions described in this analysis are those that are "reasonably foreseeable;" that is, they are ongoing (and will continue into the future), are funded for future implementation, or are included in firm near-term plans. The reasonably foreseeable time frame for future actions evaluated in this analysis is 40 years from the time the first PIB is delivered and commissioned (in 2023), which includes the period when the sixth PIB would be delivered and commissioned (assuming a 1.5-to 2-year delivery schedule, the sixth PIB could be delivered as early as 2033) with additional time allotted for shifts in delivery schedule. This time frame represents the temporal boundaries for all the alternatives. Because this is a programmatic-level assessment, the exact total number of new PIBs and delivery date of those PIBs is unknown, at this time, but subsequent impact assessments may be conducted as more information is received.

The time frame for which impacts from the Proposed Action would be expected to occur include: austral summer for the Antarctic and throughout the year for the Arctic and Pacific Northwest action areas.

5.4 Past, Present, and Reasonably Foreseeable Future Actions

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

This section focuses on past, present, and reasonably foreseeable future projects at and near the proposed action areas outlined in Section 2.1.1. Multiple databases and websites of federal (e.g., U.S. Army Corps of Engineers, Federal Aviation Administration, National Oceanic and Atmospheric Administration; U.S. Navy, U.S. Coast Guard, National Science Foundation Polar Programs), state (e.g., ADFG), local (e.g., City of Kotzebue, North Slope Borough), and private (e.g., oil and gas exploration and production companies) entities were used to collect information. Only those projects that had a relationship with the Proposed Action (such that the affected resource areas of the Proposed Action might interact with the affected resource area of the project) were considered. Projects included in this cumulative impact analysis are listed in Table 5-1 and are briefly described in their respective subsections. Categories of activities considered include:

- oil and gas exploration and production
- climate change
- commercial fishing
- shipping and cruise ships
- past commercial whaling
- commercial whaling
- subsistence hunting and harvests
- research
- pollution
- military and federal activities
- community development

The actions that would contribute the most to cumulative impacts because of their potential effects on marine species (invertebrates, fish, seabirds, sea turtles, and marine mammals), and habitats or physical environment, are: (1) oil and gas exploration and production, (2) climate change, (3) commercial fishing, and (4) shipping (including large cargo transports and cruise ships). In general, the sparse population and smaller utilization rate of the Arctic and Antarctic areas make them more pristine areas with less stressors in comparison to non-polar, more populated areas.

Resources eliminated from analysis in this PEIS (Table 2-5) were not included in the cumulative impact analysis, as the incremental contribution of the Proposed Action to cumulative impacts would be low or not relevant.

The cumulative impact analysis included the following steps (U.S. Navy 2015):

1. identify resources to consider in the cumulative impact analysis
2. define the proposed action area for each resource
3. describe the current health and historical context for each resource
4. describe direct and indirect impacts of the proposed project that might contribute to a cumulative effect
5. identify other reasonably foreseeable future actions that affect each resource
6. assess potential cumulative effects
7. report the results
8. assess the need for mitigation

Table 5-1. Projects Included in the Cumulative Impact Analysis

Location	Activity Name	Description	Timeframe
Oil and Gas Exploration and Production (Arctic Only)			
Beaufort Sea	BP Northstar Unit: offshore; various rigs and islands (e.g., Endicott Island, Liberty Project)	Reduced production but still ongoing. Several companies have left the region and there is little new exploration, although that may change in the near future with new federal energy policies (BP Exploration Alaska Inc. 2009; NMFS 2014).	Past, Present, and Future
Canadian Beaufort Sea	Multiple Canadian oil/gas exploration projects	Multiple seismic surveys and exploration work related to oil and gas development in the Canadian Beaufort Sea.	Past, Present, and Future
Canadian Polar Margin	Oil/gas exploration Arctic Islands Seismic Reflection Survey	Natural Resources Canada and Fisheries Ocean Canada, acting on behalf of the Government of Canada, is operating a project in the western Arctic Ocean (Canada Basin) to acquire necessary marine geophysical and geological data.	Past and Present
Arctic Islands and Mackenzie Delta offshore	Canadian oil/gas exploration	Ongoing exploration activities within existing oil and gas lease areas for future efforts.	Past and Present
Russian Chukchi Sea – offshore	Oil/gas exploration (seismic surveys, exploratory drilling), production, and transport	Multiple projects to explore for oil and gas development in the Russian Chukchi Sea. These include exploring subsoil use and seismic data gathering. Increased oil transport through the Bering Strait and Bering Sea	Past, Present, and Future
Climate Change			
Arctic	Climate Change	Increases in water temperature, air temperature, ocean acidification, sea level rise, and decreases in sea ice extent, thickness of ice, glaciers, and changes in salinity.	Past, Present, and Future
Antarctic	Climate Change	Increases in air temperature, ocean acidification, calving or breaking off of large sections of ice shelves, and decreases in glaciers, and changes in salinity	Past, Present, and Future
Pacific Northwest	Climate Change	Increases in water temperature, air temperature, ocean acidification, and changes in salinity.	Past, Present, and Future

Location	Activity Name	Description	Timeframe
Commercial Fishing			
Bering Sea, Chukchi and Beaufort Seas	Finfish (salmon, pollock, cod, herring) and groundfish fisheries	Primarily in the Bering Sea but small fisheries in the Chukchi and Beaufort Seas	Past, Present, and Future
Arctic Bering Sea	Invertebrate fishery (crab)	Crab fisheries in Bering Sea	Past, Present, and Future
Antarctic Ross Sea	Finfish fisheries (toothfish and icefish)	Antarctic and Patagonia toothfish, mostly outside of the Ross Sea but an exploratory fishery was conducted in the Ross Sea in 2016–2017	Past, Present, and Future
Antarctic Peninsula	Krill fishery	Krill fishery in the Antarctic outside of the Ross Sea near the peninsula and sub-Antarctic waters	Past, Present, and Future
Pacific Northwest	Finfish, groundfish and highly migratory fish	Krill, Pacific sardine, Pacific mackerel Northern anchovy, Jack mackerel, squid, rockfish, tuna.	Past, Present, and Future
Shipping and Transport			
Beaufort, Bering, and Chukchi Seas	Shipping in coastal areas	Various modes of transportation in coastal areas, marine vessel movements, transport of equipment for oil and gas exploration and production, cargo transport to coastal villages, transport of mining ore extract.	Past, Present, and Future
Beaufort, Bering, and Chukchi Seas	Shipping in offshore areas	There are various modes of transportation in the offshore areas of the Beaufort and Chukchi Seas, including marine vessel traffic, cargo transport, and oil tankers (Russian).	Past, Present, and Future
Beaufort, Bering, and Chukchi Seas	Recreation/tourism (wildlife watching, cruise ships)	The Arctic National Wildlife Refuge in the eastern Beaufort Sea, the Kaktovik area in the eastern Beaufort Sea, and offshore and nearshore areas of the Beaufort Sea. Transits through the Northwest Passage by "explorer" cruise vessels.	Past, Present, and Future
Antarctic Peninsula and Ross Sea	Recreation/tourism (wildlife watching, cruise ships)	Various locations within the proposed action area, primarily the Antarctic Peninsula but increasing traffic into the Ross Sea as ice permits.	Past, Present, and Future
Pacific Northwest	Shipping in coastal areas	The Port of Grays Harbor is located south of a large Area to be Avoided, found adjacent to the Olympic Coast National Marine Sanctuary. There are also many coastal ports in the Puget Sound area.	Past, Present, and Future

Location	Activity Name	Description	Timeframe
Pacific Northwest	Shipping in offshore areas	Includes marine vessel traffic, cargo transport, cruise ships, and oil tankers	Past, Present, and Future
Pacific Northwest	Recreation/tourism (ferries, wildlife watching, cruise ships)	Whale watching vessels depart from Seattle, the San Juan Islands, and Vancouver while cruise ports include Seattle and other ports within the Puget Sound area and Vancouver. Ferries transit between Vancouver Island and the Olympic Peninsula as well as several areas within Puget Sound.	Past, Present, and Future
Commercial Whaling			
Worldwide	Historic whaling	Was unregulated and decimated most of the populations of large whales. Many species have not recovered to pre-whaling numbers.	Past
Antarctic	Japanese whaling program	Regulated by the International Whaling Commission. Japanese commercial/research whaling program, primarily taking minke whales, 323 per year outside of the Ross Sea, Antarctica. No commercial whaling in the U.S. Arctic (see Subsistence Harvest/Hunt).	Past, Present, and Future
Subsistence Harvest/Hunt			
Arctic	Bowhead and beluga whale hunt/harvest; Various tribes	Activities by Alaska Native tribes in the North Slope communities to hunt and harvest bowhead and beluga whales, including marine vessel traffic and transportation.	Past, Present, and Future
Arctic	Bearded Ribbon, Ringed, Spotted, Harbor seals; Stellar Sea lion, Northern Fur seal hunt/harvest; Various tribes	Activities by Alaska Native tribes in the North Slope communities to hunt and harvest seals and sea lions, including marine vessel traffic and land-based transportation.	Past, Present, and Future
Arctic	Hunting, gathering, fishing, trapping and associated activities; Various tribes	Activities by Alaska Native tribes in the North Slope communities to conduct hunting, gathering, trapping and fishing activities, including marine vessel traffic and land-based transportation.	Past, Present, and Future
Arctic	Non-native hunting, fishing, trapping and associated activities	Activities by Alaskan residents permitted to conduct hunting, trapping, and fishing activities, including marine vessel traffic and land-based transportation.	Past, Present, and Future

Location	Activity Name	Description	Timeframe
Pacific Northwest	Gray whale hunt/harvest; Makah Tribe	Activities by the Makah Tribe off the coast of Washington to hunt and harvest gray whales, including marine vessel traffic and transportation	Past, Possible Present/Future
Research			
Arctic	NOAA seafloor reconnaissance in potential Arctic shipping routes	The NOAA Office of Coast Survey will be sending multiple vessels into the Arctic to survey in detail potential Arctic shipping routes to ensure the latest technology is applied to these areas to ensure vessel safety.	Present and Future
Arctic	NOAA Arctic Action Plan	Improve forecasts for sea ice, weather, and water; detect Arctic climate and ecosystem changes; advance resilient and healthy Arctic communities and economies; strengthen international cooperation and partnerships.	Present and Future
Antarctica (Ross Sea)	Multiple climate, earth sciences, glaciology, oceanography, and ecology projects	NSF Polar Programs long term science program in the Ross Sea, South Pole and Antarctic Peninsula.	Past, Present, and Future
Arctic	ANS Program	NSF Program: Supports disciplinary and interdisciplinary research related to Arctic processes and understanding the changing Arctic environment.	Past, Present, and Future
Arctic	AON	NSF Program: Study Arctic environmental system change and its global connections. Includes physical, biological, social, cultural, and economic observations, including indigenous knowledge, of the land, ocean, atmosphere and social systems.	Past, Present, and Future
Chukchi Sea	Various stakeholders: Environmental Studies Program	The Chukchi Sea Environmental Studies Program is a multi-year, multi-disciplinary marine science research program in the northeastern Chukchi Sea, funded by various stakeholders in oil and gas leases in the area.	Started in 2008 Present and Future
Bering and Chukchi Seas	University of Alaska Fairbanks Arctic Ecosystem Integrated Survey (2014)	Multiple studies designed to provide enhanced baseline information on the species composition, abundance, distribution, and ecology of the pelagic and demersal communities of the Northern Bering and Chukchi Seas.	Past
Beaufort Sea	BOEM Arctic Nearshore Impact Monitoring	ANIMIDA III will continue environmental monitoring in the Beaufort Sea, including scientific studies to characterize the oil and gas lease areas of the Beaufort Sea that expand beyond past sampling efforts conducted during prior ANIMIDA and cANIMIDA work.	Past and Present (2014–2017)

Location	Activity Name	Description	Timeframe
Beaufort Sea	BOEM/partners Marine Arctic Ecosystem Study	Integrated ecosystem dynamics and monitoring (physics, chemistry, biology, social) through coordinated observational and modeling efforts in Beaufort Sea	Past (2015–2016)
Beaufort and Chukchi Seas	NMFS National Marine Mammal Lab Aerial Surveys of Arctic Marine Mammals	Aerial Surveys of Arctic Marine Mammals is a continuation of the Bowhead Whale Aerial Survey Project and Chukchi Offshore Monitoring in Drilling Area projects to document the distribution and abundance of marine mammals in areas of potential oil and natural gas exploration and development in the Beaufort and Northeast Chukchi Seas.	Present and Future
Hanna Shoal, Chukchi Sea	BOEM and various universities, Drilling Area Offshore Monitoring	Multi-disciplinary investigation to examine the biological, chemical, and physical properties that define the ecosystem in the northern Chukchi Sea where shallow depths (12–17 ft [40–55 m]) and high bottom flow facilitate high standing stocks of biota.	Past and Present
Western Arctic Ocean	National Science Foundation, AON	Arctic System Science global change program to study physical and biogeochemical connections between the Arctic shelves, slopes, and deep basins, and global change.	Present and Future
Arctic	Russian-American Long-term Census of the Arctic; NOAA/Russian Academy of Sciences	This project fosters the joint pursuit of world oceans and polar regions science and technology activities between the United States and Russia, taking into account the mutual interests and experience of both countries.	Past, Present, and Future
Pacific Northwest	Monterey Bay Research Institute, Office of Naval Research, NSF, University of Washington, and NOAA, amongst others	Multi-disciplinary investigations to examine the biological, chemical, and physical properties that define the ecosystem, including research on populations of fish and cetaceans.	Present and Future
Pollution			
Arctic	Run Off from villages, mining, dredging	Point and non-point source pollutants from coastal runoff, offshore mineral and gravel mining, at-sea disposal of dredged materials, oil spills, sewage effluent (from shore and vessels), and marine debris	Past, Present, and Future

Location	Activity Name	Description	Timeframe
Arctic, Antarctic, and Pacific Northwest	Marine debris (fishing gear, plastic, trash, etc.)	Net and plastic band entanglement of marine species, and ingestion of plastics or plastic bags.	Past, Present, and Future
Military and Federal Agencies			
Arctic	Coast Guard ATON	Coast Guard activities to service and repair floating and land-based federal ATONs to maintain safe navigation signals within the Arctic proposed action area.	Present and Future
Arctic Bering Sea to Arctic Ocean	Arctic Shield	Provides Coast Guard presence in the Arctic during summer seasons as part of the Coast Guard's Arctic Strategy. Includes enforcement, search and rescue, and training.	Past, Present, and Future
Arctic	U.S. Military Distant Early Warning Line Sites	The Cold War Distant Early Warning Line system of 63 radar stations located across the northern edge of North America. Constructed between 1954 and 1957, and decommissioned in the 1990s. Multiple sites within the Arctic proposed action area.	Past
Arctic	U.S. Navy ICEX	U.S. Navy submarine transits through the Bering Strait and the Arctic conducting under-ice operations. These exercises have been conducted for more than 50 years.	Past, Present, and Future
Arctic	State of Alaska and Army Corps of Engineers, Arctic Deep Draft Port Study	Deep draft port facilities to accommodate the increasing human presence in the Arctic. Several port configurations are being explored, tentatively selects a plan to deepen Nome Harbor through dredging and extending the existing causeway with a 450-foot long dock.	Present and Future Finish: ~2020
Antarctica (Ross Sea –South Pole)	Operation Deep Freeze U.S. Navy – U.S. Air Force	Provide logistical support to the National Science foundation Polar Programs research program at McMurdo and the South Pole stations	Past, Present, and Future
Pacific Northwest	U.S. Navy Northwest Testing and Training	Military readiness activities of the U.S. Navy occurring in the Northwest Training Range Complex, the Naval Undersea Warfare Center Keyport Range Complex, and surrounding waters	Past, Present, and Future
Pacific Northwest	Coast Guard ATON	Coast Guard activities to service and repair floating and land-based federal ATONs to maintain safe navigation signals within the Pacific Northwest proposed action area.	Past, Present, and Future
Community Development			
Arctic (Bering Sea to Beaufort Sea)	Village infrastructure improvements	Construction of new airports, docks, roads, boat ramps, alternative energy sources (i.e., wind).	Present and Future

Location	Activity Name	Description	Timeframe
Arctic (Bering Sea to Beaufort Sea)	Kotzebue to Cape Blossom Road Project	Construction of upgrades to the existing Air Force Road and constructing a new two-lane, gravel road from Kotzebue to Cape Blossom (State of Alaska Department of Transportation and Public Facilities and U.S. DoT FHA 2013).	Present and Future
Arctic (Bering Sea to Beaufort Sea)	Quintillion cable project	Ocean laying cable to connect several communities from Nome to Oliktuk along the Bering Sea to the Beaufort Sea, began in 2016 (Quintillion Subsea Operations 2016a, 2016b)	Past and Future
Pacific Northwest	Infrastructure improvements	Construction of new airports, docks, roads, boat ramps, alternative energy sources (i.e., wind).	Present and Future

ANS: Arctic Natural Sciences; AON: Arctic Observing Network; ATON: Aids to Navigation; BOEM: Bureau of Ocean Energy Management; ICEX: Ice Exercises

5.4.1 Oil and Gas Industry (Arctic; Past, Present, and Future)

5.4.1.1 Overview

The 1998 Madrid Protocol (Antarctic Treaty Secretariat 2017) banned oil and gas exploration or production in Antarctica. Although there are oil deposits in the Antarctic, it is unlikely there will be any development in the near future. There is no oil and gas exploration or production off Washington State or the Pacific Northwest proposed action area.

Multiple oil and gas exploration activities have occurred over the last 60 years throughout the Arctic, but are generally limited in time to a specific seasonal period (summer minimum sea ice coverage) over the course of one or two years, and are individually limited in geographic extent. The majority of exploration activities and all of the production have occurred in the Beaufort Sea. Oil and gas exploration and production began in 1968 in Prudhoe Bay (NRC 2003). The Trans-Alaska Pipeline System was completed in 1977 allowing year-round transport of Beaufort Sea oil to the marine terminal in Valdez, therefore production could continue throughout the year. Federal leasing began in 1958 and the program of leasing of the outer continental shelf areas began in 1979.

5.4.1.2 Oil and Gas Projects

Current oil and gas projects that occur within the Arctic proposed action area include the Endicott Island, Liberty Project, and the British Petroleum Northstar projects in the Beaufort Sea (Table 5-1). Endicott Island began producing oil in 1987, while British Petroleum Northstar began producing in 2001 and is scheduled to continue through 2019 (BP Exploration (Alaska) Inc. 2009; National Marine Fisheries Service 2014b), and the Liberty Project is scheduled to begin in 2018 (Hilcorp Alaska 2015). A number of smaller natural gas production projects are in place in the Beaufort Sea along the North Slope (Table 5-1). Royal Shell Oil, ConocoPhillips, Repsol (a Spanish oil company), and several other oil companies have relinquished most of their leases in the Chukchi Sea due to disappointing drilling results, risk, and public pressure. Lease sales within the Chukchi and Beaufort Sea areas for the period of 2017–2022 were removed from consideration in 2015 (Department of Interior 2015). A presidential ban on new oil and gas leases in the northern Beaufort Sea (EO 13754) was issued in 2016 (81 FR 90669–90674) but on March 28, 2017 an Executive Order was issued that rescinded EO 13754, and open up oil leasing (EO 13795; 82 FR 20815–20818). Depending on world oil availability, supplies, prices, and political pressures, oil exploration and production could begin again or increase in the Arctic. In addition to the U.S. leased oil projects, several other oil and gas projects are occurring within the Canadian and Russian Arctic areas that could impact the Arctic proposed action area.

5.4.1.3 Exploration

Limited and intermittent exploration activities have taken place in offshore areas of the Chukchi Sea since the 1980s but no production activities. Ship and barge traffic to and from the Prudhoe Bay oil production areas passes through the Chukchi Sea in early summer through late fall. There are currently no State of Alaska leases in the Chukchi Sea, and there is no onshore oil and gas production along the Chukchi Sea coast. There are a number of past, present, and reasonably foreseeable future activities related to oil and gas exploration, development, and production located in Canadian and Russian Arctic areas, which include the Canadian Polar Margin, Canadian Beaufort Sea, Arctic Islands and Mackenzie Delta, and the Russian Chukchi Sea in the analysis that are included in the cumulative impact analysis.

Arctic oil exploration can only occur for part of the year—from late spring through early fall, depending on sea ice conditions. The primary impact during oil and gas exploration comes primarily from seismic surveys using air guns and secondarily from vessel noise or vessel strikes. Air guns produce underwater impulse sounds up to 240 dB SPL (re 1 μPa @ 1 m) in the low frequency range of 5–300 Hz, which can impact many marine species (Richardson et al. 1995). Seismic surveys are conducted for days or weeks, and airguns are fired off frequently, four to five times a minute (depending on ship speed) during each line transect. Noise from air guns has the potential to damage marine mammal hearing (Finneran et al. 2003; Finneran et al. 2000a; Finneran et al. 2000b; Gedamke et al. 2011; Lucke et al. 2009), elicit a behavioral disturbance (Gordon et al. 2004; Miller et al. 2009), mask communication (Di Iorio and Clark 2010; McDonald et al. 1995), or cause short or long term abandonment of affected areas (Castellote et al. 2011; Stone and Tasker 2006; Thompson et al. 1998). Air guns can also affect the abundance and distribution of fish or other prey species through changes in behavior, abandonment of areas, and decreasing recruitment, or may cause injury or mortality (Fewtrell and McCauley 2012; McCauley et al. 2000; Pacific Gas & Electric (PG&E) 2011; Turnpenny and Nedwell 1994).

Noise from engines and generators may cause marine species to leave an area temporarily or may cause masking of important sounds. There is also a threat of ship strikes to marine mammals during seismic surveys although the ships are generally moving slowly (roughly 10 knots) and protected species observers are on board or on nearby ships as part of the monitoring protocols.

5.4.1.4 Production on Offshore Drilling Rigs

Construction and maintenance of offshore oil rigs includes noise from pile driving, ice augers, construction of ice roads over water, truck/heavy equipment traffic on ice roads, vessels, helicopters and fixed-wing aircraft (Blackwell et al. 2004; Patenaude et al. 2002), and hovercraft (Blackwell and Greene Jr. 2005).

Since 1986, over 45 wells have been drilled on the Arctic Outer Continental Shelf in the Chukchi and Beaufort Seas, although only one well is currently active (Northstar Beaufort Sea: (Bureau of Ocean Energy Management (BOEM) 2016; National Marine Fisheries Service 2014b). Drilling noise recorded underwater is broadband (10–10,000 Hz) and at a sound level of about 99 dB re 1μPa (Blackwell and Greene 2006). Gas turbines and pumps run to produce electricity and move oil. These in-air sources are generally under 125 dB SPL at 100 ft (30.5 m) and are low frequency (under 1 kHz), but some of the sound may be transmitted into the water. Offshore oil spills in this region have consisted of small spills less than 31,500 gallons (119,540.5 liters). Spills may occur in small amounts as oil leaks from drilling rigs or machinery, or very large amounts may occur, such as in the blowout of the Deepwater Horizon deep drilling rig in the Gulf of Mexico (National Academy of Engineers (NAE) and National Research Council (NRC) 2012).

5.4.1.5 Oil Transport

Transporting oil via tankers increases the potential for large oil spills or Spills of National Significance, such as the Exxon Valdez spill in Prince William Sound, Alaska. Oil spills can cause short and long-term destruction to habitat and kill large numbers of marine species, particularly seabirds and marine mammals that become oiled (Loughlin 1994; Peterson et al. 2003). For species that depend on feathers or fur to maintain body temperature (e.g., seabirds, sea otters, and fur seals), oil destroys the insulating ability and prevents maintenance of body temperature. Ingestion of oil from food or grooming/preening, or inhalation of hydrocarbon vapors could also poison marine species (Helm et al.

2015; Piatt et al. 1990). Effects can persist for years as residual oil continues to seep from benthic areas and many prey species may be slow to rebound to pre-spill population levels, thus the populations of top predators may also remain depressed.

The oil extracted from the U.S. Beaufort Sea area passes through the Trans-Alaska Pipeline from Prudhoe Bay to the marine terminal at Valdez; therefore, most of the transporting of oil is conducted outside of the Arctic proposed action area. There is oil transported in the Arctic proposed action area to provide fuel to the many small towns and villages in the remote coastal areas of Alaska. In addition, Russia uses large oil tankers to transport oil from Siberia along the Northern Sea Route, then south through the Bering Strait to markets in Asia. Russia is expected to increase shipments of oil and natural gas in the near future. A Russian oil tanker leak or a rupture could affect the shores and EEZ of the United States in the Bering and Chukchi Seas.

5.4.1.6 Cumulative Impact Analysis

The Proposed Action would benefit the environment because an important aspect of the Coast Guard's mission is to assist and coordinate the clean-up of oil spills or of other hazardous materials. The Coast Guard trains for Spills of National Significance and has developed procedures, along with the EPA, which would be implemented via the Alaska Federal/State Preparedness Plan for Response to Oil and Hazardous Substance Discharges/Releases, if and when these procedures are necessary. Additionally, the Coast Guard serves as the primary maritime law enforcement agency, provides assistance for any oil spill, and has the authority to carry out programs to further protect and conserve marine species and habitats. While actual marine environmental response is not part of the Proposed Action, during an actual emergency, a deployed floating U-shaped boom would be attached to a pump and used to corral oil, which would then be pumped into a tank on a PIB.

Oil and gas activities in the Arctic result in underwater noise that may impact marine species and present a potential vessel collision risk for marine mammals. In addition, oil spills from ships or oil drilling platforms can impact the environment and any marine species in the area. Resources potentially impacted include marine vegetation, fish, seabirds, sea turtles, marine mammals, and socioeconomic environment (as defined in Section 3.3) in the area. Coast Guard operations and training including vessels, aircraft, and icebreaking activities may add a small amount of noise to the environment, but it would be considered insignificant when compared to the sounds introduced into the environment from air guns or seismic survey vessels (along with other support or marine species survey vessels). The protective measures described in Chapter 6 would also minimize impacts, specifically, the risk of a vessel collision with a marine mammal. Therefore, implementation of the Proposed Action combined with the past, present, and reasonably foreseeable future projects would not significantly add to cumulative impacts in the Arctic proposed action area.

5.4.2 Climate Change (Arctic, Antarctic, and Pacific Northwest; Past, Present, and Future)

5.4.2.1 Overview

Climate change affects the amount, geographic extent, and distribution of sea ice habitat, and the presence of warmer water temperatures will affect the abundance and distribution of prey species for higher predators (fish, sea birds, and marine mammals) in the Arctic, Antarctic, and Pacific Northwest areas. The polar regions, in particular Arctic sea ice, are especially sensitive to climate change as has been made evident by the continual decrease in the maximum extent and volume of both annual and multiyear ice. The Antarctic Ocean has become a large heat and CO_2 sink, which has mediated some of the impact of climate change within the Antarctic Region (Tollefson 2016); therefore, the Antarctic has not been affected as much as the Arctic Region by climate change.

Climate change impacts in the Arctic, Antarctic, and Pacific Northwest (Arctic Council 2004; Mathis 2011; National Snow and Ice Data Center 2017a; Payne et al. 2012; Raven J.K. et al. 2005; Scientific Committee on Antarctic Research (SCAR) 2016) consist of:

- increase in water temperatures (Arctic, Antarctic, Pacific Northwest)
- increase in air temperatures (Arctic, Antarctic, Pacific Northwest)
- increase in ice shelf/sheet cracks and breakoffs (Arctic and Antarctic)
- increase in ocean acidification (Arctic, Antarctic, Pacific Northwest)
- rising sea levels (Arctic)
- decreasing and retreating glaciers (Arctic and Antarctic)
- decrease in sea ice extent and thickness (Arctic)
- changes in salinity (Arctic, Antarctic, Pacific Northwest)

Several seal and penguin species, as well as polar bears, rely on sea ice for reproduction (egg laying and incubation, pupping and nursing, denning), resting, escaping predators, or molting. Therefore, the loss or reduction of sea ice habitats may decrease reproductive rates and survival, especially for newly fledged/weaned young, and decrease the populations of marine species that utilize sea ice habitats (Descamps et al. 2017; Hamilton et al. 2015; Huntington et al. 2016; Kovacs K.M. et al. 2011; Laidre et al. 2015; Regehr et al. 2016; Simmonds and Isaac 2007). Native Alaskans would also be affected by sea level rise, possibly causing the flooding of coastal villages and changing in the distribution of harvested resources, which would require hunters to travel further away from their villages. Due to the loss or reduction of sea ice habitats, hunters would also be required to travel further offshore to find resources.

5.4.2.2 Cumulative Impact Analysis

The Proposed Action would benefit the environment because an important aspect of the Coast Guard's mission is to assist in research on climate change within the Arctic, Antarctic, and Pacific Northwest proposed action areas. Research is ongoing and the Coast Guard provides a substantial amount of the support to those research programs.

Changes in sea ice and the increase in water temperature have affected the abundance and distribution of marine species. Resources potentially impacted include marine vegetation, EFH, fish, invertebrates, seabirds, and marine mammals. The majority of the impacts from climate change in the Arctic and Antarctic are caused by sources beyond those areas; therefore, the contribution of the Coast Guard's Proposed Action would be insignificant because of the overall limited ship and aircraft usage in the polar regions, and the intermittent nature of the PIB activities. Icebreaking a path through the sea ice is a temporary condition and does not destroy large areas of sea ice that may reflect sunlight. The path may freeze over and/or fill in with ice from currents or winds soon after the ship has passed through. Much of the ice that icebreaker vessels travel through is annual ice that would regularly melt each summer.

5.4.3 Commercial Fishing Industry (Arctic, Antarctic, and Pacific Northwest; Past, Present, and Future)

5.4.3.1 Overview

Commercial fishing can be seasonal or year-round depending on the target species. Seasonal fisheries for groundfish, finfish, krill, and shellfish species are conducted annually in the Arctic, Antarctic, and Pacific Northwest, although commercial fishing has been prohibited in the Arctic Ocean since 2009 (74 FR 56734; December 3, 2009). Most commercial fishing activities occur in summer, although some fish and invertebrate species can be fished throughout most of the year.

The Coast Guard serves as the primary maritime law enforcement agency and has the authority to carry out programs to further protect and conserve marine species and habitats and protect against poaching. In addition, the Coast Guard provides valuable emergency services (e.g., search and rescue, medical evacuations) to commercial fishing communities throughout the proposed action areas.

5.4.3.2 Arctic Fisheries

The Bering Sea is seasonally one of the most biologically productive areas in the world with fisheries for finfish, groundfish, and several species of crab. Groundfish, salmon, and shellfish fisheries extend up to the Chukchi and Beaufort Seas but are not as plentiful as in the Bering Sea to the south. Consequently, the fisheries within the Chukchi and Beaufort Seas are much smaller with fewer boats and personnel involved. EFH is designated within the Arctic proposed action area for scallops, groundfish, salmon, and crab (Table 3-5).

5.4.3.3 Antarctic Fisheries

Krill, icefish, and Antarctic and Patagonia toothfish are the main species fished in Antarctic waters (Commission for the Convention of Antarctic Marine Living Resources 2017a). Krill is a major food source for large whales, several pinniped and seabird species, and fish; therefore, overfishing may affect higher predators. The krill fisheries operate in the northern end of the Antarctic Peninsula, north to the South Shetland Islands and South Georgia Island (Commission for the Convention of Antarctic Marine Living Resources 2017b) outside of the Antarctic proposed action area. There was an exploratory fishery for Patagonia and Antarctic toothfish in the Ross Sea area during 2016 to 2017 (Commission for the Convention of Antarctic Marine Living Resources 2017c). There is no EFH designated within the Antarctic proposed action area.

5.4.3.4 Pacific Northwest Fisheries

Groundfish, northern anchovy, Pacific herring, Pacific sardine, market squid, salmon, and shellfish are all found in the offshore area. Groundfish, tuna, salmon, and crab are important commercial fisheries in the Pacific Northwest. The EFH for groundfish and salmon overlap with eastern portion of the Pacific Northwest proposed action area. EFH is designated within the Pacific Northwest proposed action area for krill, finfish, groundfish, and highly migratory species (Table 3-6).

5.4.3.5 Vessels

Noise from engines and generators may cause marine species to leave an area temporarily or may cause masking of important sounds. Prop-wash and wave action from vessel operations in nearshore, narrow, and shallow waters will increase sediment suspension and turbidity. Lethal vessel collisions are more likely with larger fishing/factory vessels than smaller fishing boats (Jensen and Silber 2003; Neilson et al. 2012).

5.4.3.6 Entanglement in Fishing Gear

Entanglement in fishing gear could be from active, abandoned, or lost fishing lines or nets (National Marine Fisheries Service 2017c, 2017d). Entanglement of marine species, especially marine mammals, is an increasing threat to many species, in particular in the Arctic; 78 percent of humpback whales have scars from past entanglements (National Marine Fisheries Service 2017c, 2017d; Neilson 2006). Injuries, strandings, or mortality from discarded or ghost fishing gear and marine debris is estimated to be up to 15.4 percent in California sea lions per year, 4.2 percent in North Atlantic right whales per year, 6 percent in sea turtles per year, and 0.2–1.2 percent of seabirds on the U.S. West Coast per year (NOAA 2014).

5.4.3.7 Prey Abundance and Distribution

Over-fishing by commercial fisheries, along with cumulative impacts of climate change and pollution, may impact the abundance and distribution of prey species which would affect higher predators such as fish, seabirds and marine mammals. Fishing is closely regulated in the Arctic by the ADFG and NMFS, by Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) in the Antarctic, and Washington Department of Fish and Wildlife and NMFS in the Pacific Northwest in order to prevent over-fishing; the Coast Guard assists in enforcing those fishing regulations.

5.4.3.8 Cumulative Impact Analysis

Coast Guard presence would help to prevent poaching of fish or invertebrates, particularly from foreign vessels, and enforce violations under the ESA, the Magnuson-Stevens Act, and other applicable laws. By enforcing fisheries regulations, aiding the removal of abandoned fishing gear, and cleaning up other marine debris or oil spills, the Coast Guard provides beneficial services.

Resources potentially impacted include targeted and bycatch fish and invertebrates, and incidental catch or entanglement of seabirds, marine mammals, and sea turtles. In the Arctic and Pacific Northwest proposed action areas, there would be a small increase in ocean noise and vessel traffic from Coast Guard icebreakers, small boats, and aircraft, but any effects would be minor and temporary. In the Antarctic, noise and traffic would also increase when the icebreaker breaks a path to McMurdo Station or supports research projects in the Ross Sea, but the effects would be minor and temporary. The Coast Guard does not participate in commercial fishing and therefore, would not remove catch from the commercial fishery industry. Coast Guard activities would coincide with Arctic (Alaskan), Antarctic, and Pacific Northwest fisheries, but effects would only be minor and temporary, and would not significantly impact those fish populations or fisheries.

5.4.4 Shipping and Transportation (Arctic, Antarctic, and Pacific Northwest; Past, Present, and Future)

5.4.4.1 Overview

Marine vessel traffic includes commercial (e.g., cargo transport, oil tankers), military, and recreational vessels and small watercraft. The decrease in Arctic sea ice has led to an increase in the use of Arctic shipping lanes and in vessel traffic of both commercial transport and cruise ships through the Arctic Ocean (U.S. Coast Guard 2016). Shipping in polar regions occurs primarily in the Northern Hemisphere. There is little shipping activity in the Antarctic with the exception of resupply vessels to research stations and cruise ships during the summer. In general, most shipping is restricted to late spring through early fall due to ice and weather conditions. The Pacific Northwest serves as a gateway for shipping and transportation and it occurs year-round.

5.4.4.2 Vessel Noise

Marine species may temporarily leave an area of high ship noise, or the increased noise could affect their ability to communicate or may mask anthropogenic noise. This may mean species need to vocalize louder, more frequently, or stop vocalizing until the noise has ended or that species may not be able to hear important sounds (i.e., dependent young, predators).

5.4.4.3 Vessel Collisions

Vessel collisions predominantly impact large baleen whales (Jensen and Silber 2003; Neilson et al. 2012). Sighting marine mammals from a large container ship can often be difficult due to the cargo carried on the ship, sighting conditions, or availability of a dedicated marine observer on the bridge. In addition, even if a marine mammal is sighted, large ships are often unable to effectively maneuver or stop to avoid a collision if a whale were to cross its path.

5.4.4.4 Cumulative Impact Analysis

The presence of the Coast Guard would help protect shipping and the U.S. citizens on those vessels, provide emergency services if necessary, assist in the containment and cleanup of vessel oil spills, and would enforce violations under the International Convention for the Prevention of Pollution from Ships (MARPOL), the Antarctic Conservation Act, and other applicable laws.

Resources potentially impacted from commercial shipping would include all marine species and habitats in the event of a vessel oil spill, and seabirds and marine mammals from vessel strikes. There would be a small increase in ocean noise from Coast Guard icebreakers, small boats, aircraft, and icebreaking. This would be a small part compared to the large number of cargo or oil tanker vessels used in the polar areas and would not significantly add to cumulative impacts. Coast Guard icebreakers would have trained lookouts on the bridge or bridge wings as part of ship's SOPs when underway; this would reduce the likelihood of a vessel collision with marine species when compared to the risk of a vessel collision between marine species from commercial vessels.

5.4.5 Recreational/Cruise Ships (Arctic, Antarctic; and Pacific Northwest; Past, Present and Future)

Travel and tourism to and throughout the Arctic and Antarctic via cruise ships is a small but important industry that is likely to increase in the foreseeable future, particularly with decreasing sea ice which would allow ships to transit further into polar regions. Cruise ships, ferries, and whale watching vessels also operate in the Pacific Northwest.

5.4.5.1 Arctic

Alaska is home to glaciers and passages that enable cruise ships to bring passengers alongside wildlife and can cover a vast area in this region. Recently, there have also been several cruise ships traveling through the Northwest Passage into the Arctic Ocean. With changing sea ice conditions, previously inaccessible areas, may become accessible and the number of cruise ships in the Arctic Ocean is likely to increase. At present, the number of cruise ships is small, but if their presence continues to increase, it is anticipated that more demands may be placed on the Coast Guard serving the Arctic. Cruise ships are also likely to increase vessel noise in areas in which they operate and may disturb wildlife during transit (e.g., marine mammals) or during excursions ashore. Prop-wash and wave action from vessel operations in nearshore and shallow waters would increase bottom sediment suspension and turbidity, but vessel size would determine the waters in which this would occur.

5.4.5.2 Antarctica

Expeditions to Antarctica typically involve a cruise ship with smaller vessels (e.g., zodiacs) used for shore excursions. These cruise ships commonly journey around the Antarctic Peninsula, Drake Passage, the Falkland Islands, South Georgia and South Shetland Islands. Some cruise ships enter the Ross Sea each year with some traveling as far as McMurdo Station, and it is anticipated that the Coast Guard would continue to serve the Antarctic, including the cruise ship industry. Cruise ships are likely to increase vessel noise in areas of operation and may disturb wildlife during transits (e.g., marine mammals) or during excursions ashore (e.g., visiting penguin colonies). Prop-wash and wave action from vessel operations in nearshore and shallow waters will increase bottom sediment suspension and turbidity, but vessel size would determine the waters in which this would occur.

5.4.5.3 Pacific Northwest

Cruise ships, ferries, and whale watching vessels commonly travel between ports in the Puget Sound area, Seattle, and British Columbia. The Coast Guard currently serves the Pacific Northwest area, and it is anticipated that as recreational ships continue to increase in the area, it is likely that the demand for Coast Guard would reflect that increase in demand. Recreational ships are likely to increase vessel noise in areas in which they operate and may disturb wildlife during transits (e.g., marine mammals) or during excursions ashore. Prop-wash and wave action from vessel operations in nearshore and shallow waters will increase bottom sediment suspension and turbidity, but vessel size would determine the waters in which this would occur (coastal or offshore areas).

5.4.5.4 Cumulative Impact Analysis

Similar to the information provided in Section 5.4.3.1, the presence of the Coast Guard would help protect recreational ships and the U.S. citizens on those vessels, provide emergency services if necessary, assist in the containment and cleanup of vessel oil spills, and would enforce violations under MARPOL, the Antarctic Conservation Act, and other applicable laws.

Resources potentially impacted from commercial shipping would include all marine species and habitats in the event of a vessel oil spill, and seabirds and marine mammals from vessel collisions. There would be a small increase in ocean noise from Coast Guard icebreakers, small boats, aircraft, and icebreaking. This would be a small part compared to the other vessels in the proposed action areas and would not significantly add to cumulative impacts. Coast Guard icebreakers would have trained lookouts on the bridge or bridge wings as part of ship's SOPs when underway; this would reduce the likelihood of a vessel collision with a marine species when compared to the risk of a vessel collision between marine species from recreational vessels.

5.4.6 Homeport and Visiting Ports (Pacific Northwest and Global; Present and Future)

Since the current fleet of icebreakers are homeported in Seattle, Washington, it is possible that some of the Coast Guard icebreakers would also be homeported in the Seattle/Tacoma area; however, the Coast Guard has not yet conducted a homeport feasibility study. Seattle-Tacoma seaport is one of busiest in the United States (measured by overall twenty-foot equivalent cargo container units [TEU] volume) and is used by cruise, tug, cargo container, and oil transport ships (CBRE Research 2015). Vessels using the port include cargo containers, cruise ships, U.S. Navy ships (including some home ported), ferries, personal or recreation vessels, tugboats, and fishing vessels. Ships use the Pacific Northwest proposed action area when approaching or leaving from the south of Puget Sound.

In transit to or from the Arctic or the Antarctic, the Coast Guard icebreakers may visit ports within Alaska, Greenland, Hawaii, New Zealand, Australia, South Africa, and South America. These ports have small and large vessel traffic including cargo container ships, cruise ships, Navy ships, ferries, personal or recreation vessels, tugboats, and fishing vessels.

5.4.6.1 Cumulative Impact Analysis

Coast Guard presence in the Arctic, Antarctic, and Pacific Northwest proposed action areas is important to enforce environmental and safety regulations, and to provide search and rescue assistance if necessary. Within the homeport area and the ports visited during transit, the amount of sound or greenhouse gases produced by the Coast Guard ships would be insignificant, and any impacts would be minor and temporary in comparison to the many different types and number of vessels using these ports. Coast Guard activities would not significantly add to cumulative impacts of homeporting activities in the Pacific Northwest Action area or other ports visited by the icebreakers.

5.4.7 Commercial Whaling (Arctic, Antarctic, Pacific Northwest; Past Only)

5.4.7.1 Overview

Commercial whaling decimated many large whale species including those that made seasonal migrations to the Arctic, Antarctic, and Pacific Northwest Regions to feed and breed (e.g., gray whales, right whales, humpback whales, etc.). The effects of past commercial whaling are still widespread as most species have not recovered to pre-whaling population numbers and remain listed as endangered or threatened under the ESA, as a depleted or a strategic stock under the MMPA, or as vulnerable or endangered under the International Union for Conservation of Nature (IUCN) Red List. For example, the North Pacific right whale is critically endangered with only a small remnant population of 31 whales, primarily residing in the Gulf of Alaska and the Bering Sea (Muto et al. 2017).

5.4.7.2 Cumulative Impact Analysis

The Coast Guard has never participated in commercial whaling and the Proposed Action would not involve commercial whaling or lethal takes of any whales, and none of the proposed activities would lead to future commercial harvesting of whales.

5.4.8 Commercial Whaling (Arctic and Antarctic; Past, Present, and Future)

5.4.8.1 Overview

In 1986, the IWC banned commercial whaling; however, there are still some countries that do whale, particularly in the Southern Ocean. There continues to be small amount of commercial/research whaling in the Antarctic (Japan) and North Atlantic/Arctic (Iceland and Norway), and native subsistence harvests in the Arctic. Norway and Iceland continue to hunt whales but only in the North Atlantic outside of the proposed action areas. No commercial whaling takes place in the U.S. Arctic or Pacific Northwest proposed action areas, although subsistence harvests do occur in coastal areas (see Sections 3.3.4.1 and 3.3.4.2).

Japan still operates a whaling fleet that primarily takes minke whales in Antarctica for “scientific research,” as opposed to commercial whaling (IWC 2017). Japan’s whaling occurs in the East Antarctic region (IWC zones IV, V and VI within the Australian Sector), adjacent to but not in the Ross Sea (Konishi et al. 2008). Political pressure (from Australia and New Zealand), legal issues (an International Court of Justice ruling against Japan’s whaling program: (International Court of Justice (ICJ) 2014)), and environmental activists (i.e., the Sea Shepard anti-whaling campaign) may reduce or stop Japan’s whaling program in the Antarctic in the future.

5.4.8.2 Cumulative Impact Analysis

Potential impacts (primarily behavioral disturbance) on marine mammals from Coast Guard related PIB activities from vessel or aircraft sound, would be short term and temporary, and not expected to result in population level impacts for any affected species with implementation of appropriate mitigation measures. Coast Guard activities would not significantly add to cumulative impacts to the abundance or distribution of whales. The Proposed Action would not involve lethal takes or injury of any whales, and none of the proposed activities would lead to future commercial harvesting of whales. Coast Guard presence in these areas would be important to enforce environmental regulations.

5.4.9 Subsistence Harvest/Hunting (Arctic and Pacific Northwest; Past, Present and Future)

5.4.9.1 Overview

Tribal communities in the Arctic and Pacific Northwest proposed action areas place a high value on being able to hunt, fish, and to live off the land. Subsistence hunting and gathering is viewed as a core value of traditional cultures. Such activities further values of kinship, cooperation, and reciprocity. Although all activities in the proposed action areas are permitted in accordance to State and Federal regulations, it is important to consider the impacts of such harvests into the cumulative impact analysis.

5.4.9.2 Arctic Marine Mammals

A number of pinniped and cetacean species, including beluga whales, bowhead whales, harbor seals, bearded seals, ringed seals, ribbon seals, spotted seals, Steller sea lions, and northern fur seals, are taken annually by native communities in Alaska as part of the subsistence harvest (Muto et al. 2017; National Oceanic and Atmospheric Administration (NOAA) Fisheries-Alaska Regional Office 2017a, 2017b). Currently up to 51 bowhead whales may be taken per year in U.S. Arctic waters. An average of 292 beluga whales per year are harvested from the eastern Bering Sea, eastern Chukchi Sea, and the Beaufort Sea (Muto et al. 2017). Estimates of the harvest of pinnipeds that inhabit the Arctic proposed action area is an average of 390 bearded seals per year, three ribbon seals per year, 1,050 ringed seals per year, 5,265 spotted seals per year (last estimate from 2000), 137 Steller sea lions per year, and 432 northern fur seals per year (Muto et al. 2017).

5.4.9.3 Arctic Fish and Marine Invertebrates

Native and non-native finfish (e.g., cod, halibut, herring, salmon, and smelt) and shellfish (i.e., crabs and clams) subsistence fishing is authorized under the State of Alaska subsistence hunting. A native subsistence halibut harvest takes place in the nearshore areas of the Bering Sea and up into the Chukchi Sea within the Arctic proposed action area (National Oceanic and Atmospheric Administration (NOAA) Fisheries-Alaska Regional Office 2017c).

5.4.9.4 Pacific Northwest Marine Mammals

Federally-recognized tribes in the Pacific Northwest action area practice a subsistence lifestyle centered on fishing for sea otters, whale and seal, smaller species such as shellfish, and trading these products with other Tribes (Tiller 2015a). Historically, this subsistence lifestyle was dominated by the use of seal and whale oil (Tiller 2015b), however most tribal economies are now based on gaming, tourism, media and communications, small commercial development, logging, and fishing. In 2005, the Makah Indian Tribe submitted to NMFS a request to resume treaty-based hunting of eastern North Pacific gray whales for subsistence and ceremonial purposes.

5.4.9.5 Pacific Northwest Fish and Marine Invertebrates

A large percentage of the tribal population in the Pacific Northwest engage in employment from fishing for salmon, groundfish, and urchin (Freedman et al. 2004). Some species that move through the Pacific Northwest proposed action area are culturally significant to these tribes. Procurement of traditional resources, such as marine invertebrates and fish, is regulated by geographical area (e.g., usual and accustomed fishing grounds), fishing methods, season, and species limits per day or per size.

Four federally-recognized Washington Tribes are currently or historically associated with the Pacific Northwest proposed action area. These Tribes in Washington have off-reservation Treaty usual and accustomed fishing grounds. The Pacific Northwest proposed action area is completely outside of all Tribal usual and accustomed fishing areas, as they are located further inshore.

5.4.9.6 Cumulative Impact Analysis

The Proposed Action is not expected to significantly add to the cumulative impacts from the subsistence use of marine mammals, fish, or shellfish. Coordination would occur between the Coast Guard and Alaska and Pacific Northwest Native subsistence hunting groups during vessel and aircraft movements once subsistence whaling and fishing seasons begin. Particularly in Alaska, Coast Guard flights would be coordinated with local governments and tribes to ensure that flight paths do not disrupt planned subsistence hunts. In addition, Coast Guard presence in the Arctic proposed action area is important to enforce environmental and safety regulations, and to provide search and rescue assistance if necessary.

The Proposed Action may cause a small and temporary disturbance to marine mammals and fish but no long-term abandonment, decrease in reproduction, or mortality to harvested species. Additionally, no cumulative impacts are expected to prey abundance or distribution. The Coast Guard is often the only enforcement in remote parts of the Arctic enforcing environmental regulations, such as those included in the ESA, MMPA, and Magnuson-Stevens Act.

5.4.10 Research (Arctic, Antarctic, and Pacific Northwest; Past, Present and Future)

5.4.10.1 Overview

Various ongoing scientific studies are conducted by Federal and State agencies, universities, and other organizations. Research activities include bathymetric mapping and oceanographic research using vessels, deployment of acoustic equipment for marine mammal surveys, and bird and marine mammal visual surveys using vessels or aircraft. Research activities may involve vessel, air, and on-ice hovercraft. Research may contribute to cumulative impacts through disturbance of marine species, impacts to subsistence harvest through vessel and aircraft traffic, and disturbance of bottom sediment through sampling. Activities related to scientific research of biological systems requires some human presence and interaction with wildlife, such as sampling, tagging, or tracking species of interest. Other types of research include physical processes and investigating systems in the proposed action areas and often involve a variety of support vessels. Research in each of the proposed action areas is expected to increase. While such activities are necessary and beneficial, they may also contribute adverse cumulative effects to water quality, acoustic environment, coastal and marine habitats, and coastal and marine fauna.

5.4.10.2 Acoustic Disturbance

Acoustic impacts would be primarily from seismic survey airguns, depth and fish finding sonars, and vessels and aircraft used for research. Loud noise from seismic surveys that use air guns for geophysical or bathymetric surveys has the greatest potential to disturb or injure marine species. Seismic survey air guns produce impulse sounds at 120 to 190 dB_{RMS} in a frequency range below 1,000 Hz (primarily below 250 Hz; (DeRuiter et al. 2006)) which could impact large whales, seals, sea birds and fish. Echosounders (fish finders) for fisheries research (i.e., fish or crustacean abundance and distribution) are widely used during surveys. Echosounder systems for fish stock assessments produce impulse sounds up to 226 dB SPL, generally at much higher frequencies (up to 200 kHz) than most marine species can hear; therefore, echosounders impact fewer species. Research projects that may disturb marine species would be expected to have authorization through a scientific research permit and mitigation measures that would be implemented to minimize disturbance.

5.4.10.3 Arctic

The NSF’s Office of Polar Programs supports several research programs to monitoring the Arctic including the Arctic Observing Network (AON; which tracks environmental system change and its global connections), the Arctic Natural Sciences program (which supports disciplinary and interdisciplinary research related to Arctic processes and the changing Arctic environment). The Bureau of Ocean Energy Management (BOEM) has supported a number of Arctic projects on the bathymetry, geology, and distribution of animals in areas where oil exploration occurs (e.g., ANIMIDA III- study of contaminants, sources, and bioaccumulation in the Beaufort Sea area and Marine Arctic Ecosystem Study). The Russian-American Long-term Census of the Arctic is funded by NOAA and the NSF Arctic Observing Network Program, to understand and ultimately predict the effects of climate change in the northern Bering and Chukchi Seas. The ADFG, NMFS Alaska Fisheries Science Center, and NMFS Marine Mammal Laboratory have had ongoing research in the Arctic Ocean, Chukchi Sea, and Beaufort Sea on invertebrates, fish, ice seals, and cetaceans (Alaska Department of Fish and Game 2017e). Marine species may be disturbed by tagging, capture, or presence of vessels or aircraft in the area. Research projects that may disturb marine species or the environment will undergo some form of federal and state environmental analysis before beginning (e.g., NEPA, ESA, MMPA etc.), and mitigation measures and monitoring may be required.

5.4.10.4 Antarctic

Research via NSF USAP has been ongoing for several decades. Research projects include astrophysics, earth sciences, glaciology, ecology, population dynamics, and physiological and behavioral adaptations of marine organisms. Many countries, such as France, Italy, Australia, Russia, and New Zealand as well as international groups such as the Scientific Committee on Antarctic Research (SCAR) and the CCAMLR have ongoing atmospheric, biological, geologic, or oceanographic related research projects in or near the Ross Sea. Marine species may be disturbed by tagging, capture, or the presence of vessels or aircraft in the area. Research projects that may disturb marine species or the environment will undergo some form of federal and international environmental analysis before beginning (e.g., NEPA, SCAR, Antarctic Treaty, MMPA etc.) and mitigation measures and monitoring may be required.

5.4.10.5 Pacific Northwest

The Monterey Bay Research Institute, the Office of Naval Research, NSF, the University of Washington, and NOAA have had ongoing research in the Pacific Northwest on habitats and populations of invertebrates, fish, and marine mammals. Marine species may be disturbed by tagging, capture, or presence of vessels or aircraft in the area. Research projects that may disturb marine species or the environment will undergo some form of federal and state environmental analysis before beginning (e.g., NEPA, ESA, MMPA etc.), and mitigation measures and monitoring may be required.

5.4.10.6 Cumulative Impact Analysis

Coast Guard presence in the proposed action areas is important to enforce environmental and safety regulations, to provide search and rescue assistance if necessary, and often to provide transport and logistics for science teams. The Coast Guard would not use any loud sound sources such as air guns, but as part of their navigational systems, would use depth sounders. Depth sounders are expected to result in responses that are short term and inconsequential based on system acoustic characteristics (i.e., short pulse length, narrow beam width, downward directed beam, high frequency etc.) and manner of system operation. Coast Guard activities would add noise to the environment from vessels, aircraft, and icebreaking (Arctic and Antarctic proposed action areas only), but this would be a small amount compared to other ongoing research activities.

Researchers may use Coast Guard ships or small boats as a platform for studies using tagging or biopsies, vessel and aerial surveys, and photo-identification. Permits for capture or handling animals would be authorized by NMFS for each scientist or project, not by the Coast Guard. Coast Guard personnel would not be capturing or handling animals or making close approaches to animals, and their activities would be minor compared to research activities, and would not add to cumulative impacts to marine species, fisheries, prey abundance, or distribution.

5.4.11 Pollution (Arctic, Antarctic, and Pacific Northwest; Past, Present and Future)

5.4.11.1 Overview

Marine species can be exposed to contaminants via the food they consume and the water in which they live. The persistent organic pollutants (e.g., Aldrin, DDT, PCB) from agriculture and industry tend to bio-accumulate (increase in concentration) through the food chain; therefore, the chronic exposure of persistent organic pollutants in the environment affects high trophic level predators such as large fish, sea birds, and marine mammals. Point and non-point source pollutants from coastal runoff, offshore mineral and gravel mining, at-sea disposal of dredged materials, oil spills, sewage effluent (from shore and vessels), marine debris, and organic compounds from aquaculture are all lasting threats to marine species in the proposed action areas. The long-term impacts of these pollutants, however, are difficult to measure. In addition, marine debris, such as plastic bands, plastic bags, small pieces of plastic, discarded rope, or fishing gear (see Section 5.4.3) can injure or kill marine species. Plastic bands could cut through tissue as the animal grows, and ingestion of plastics or plastic bags can damage or block the gastrointestinal tract.

5.4.11.2 Cumulative Impact Analysis

Coast Guard presence in the Arctic, Antarctic, and Pacific Northwest proposed action areas is important to enforce environmental and safety regulations. Resources potentially impacted from pollution include all marine species from short and long-term exposure. The Coast Guard's proposed activities are not expected to cause a significant increase in the exposure of contaminants to marine species in the proposed action areas due to the small scale of the activities and because the Coast Guard strictly adheres to SOPs regarding at-sea waste disposal and the International Convention for the Prevention of Pollution from Ships (MARPOL VI). In addition, the benefit of Coast Guard oil spill response and recovery efforts would offset any minor impacts associated with the potential risk for unintentional oil spills from PIBs.

5.4.12 Military Activities (Arctic, Antarctic, and Pacific Northwest; Past, Present and Future)

5.4.12.1 Overview

As the polar regions become increasing accessible, military activities are expected to increase in order to respond to the resulting changes in environmental and geopolitical situations. The PIB program would facilitate the Coast Guard's ability to respond to and support military activities in the Arctic, Antarctic and Pacific Northwest action areas. While such activities are necessary and beneficial, they may also contribute adverse cumulative effects to climate change, water quality, acoustic environment, coastal and marine habitats, and coastal and marine fauna.

5.4.12.2 Arctic

In 2013, the Department of Defense developed the "Arctic Strategy" to maintain stability and security within the Arctic Region with the ongoing environmental and geopolitical changes (Department of Defense 2013). Decreases in the extent of sea ice as a result of climate change has allowed increased access to the Arctic Ocean region by Arctic nations (i.e., United States, Russia, Canada, Norway etc.) and non-Arctic nations alike that are attempting to establish their position in the region to acquire the anticipated abundant resources and gain access to the new trade routes.

The U.S. Navy is preparing for the continued increase in access by other countries in the Arctic Ocean due to decreases in sea ice extent that open large previously unnavigable areas (U.S. Navy 2014b). The Navy has regular inter-fleet transfers, training (Ice Exercises [ICEX]), and research expeditions (Science Ice Expeditions [SCICEX]) throughout the Arctic Ocean, primarily using submarines. Submarines are extremely quiet compared to surface vessels and run on nuclear power, therefore, they do not produce greenhouse gases. Those activities are likely to continue in the future and may expand. U.S. Army personnel and U.S. Air Force aircraft have also been deployed temporarily to the Arctic for training exercises that will likely continue in the future. Additionally, Coast Guard field units work in the Arctic to install and maintain the system of Aids to Navigation (ATON). ATON includes lighted and unlighted buoys, lighted and unlighted fixed structures such as day beacons and lights, ranges and lighthouses.

5.4.12.3 Antarctic

The Joint Task Forces Support Forces Antarctica (Operation Deep Freeze) oversees all U.S. Air Force, Air National Guard, Air Force Reserve Command, Navy, and Coast Guard personnel who support the U.S. Antarctic Program (National Science Foundation (NSF) United States Antarctic Program (USAP) 2017). The Navy has a long history of involvement with polar exploration and logistics in Antarctica. The U.S. Navy's activities have decreased in recent years as the NSF's Polar Programs has assumed more responsibility, but the U.S. Navy continues to manage communications and some aircraft logistics.

The U.S. Air Force and the Air National Guard conduct the aircraft flights between New Zealand and McMurdo Station, and McMurdo Station and the South Pole during the Austral summer season (August through February). The U.S. Air Force maintains and operates the C17 and ski equipped C-130 cargo aircraft for transporting personnel and cargo between New Zealand and the Antarctic bases as part of the annual Operation Deep Freeze under the Joint Task Forces Support Forces Antarctica. Flights occur several times a week depending on weather, with additional local flights by smaller twin-engine fixed wing aircraft and helicopters. Both the Navy and U.S. Air Force activities in the Antarctic are likely to remain stable for the near future.

5.4.12.4 Pacific Northwest

In the Pacific Northwest, there is a continuous military presence by the U.S. Navy, Air Force, Coast Guard, and the Army. The U.S. Navy Northwest Training and Testing exercises consist of military readiness activities that maintain, train, and equip combat-ready forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. These training and testing activities primarily occur within existing range complexes, operating areas, and testing ranges at sea, and at select Navy pier side locations in the Pacific Northwest. The Coast Guard field units work in the Pacific Northwest to install and maintain the system of ATON.

5.4.12.5 Cumulative Impact Analysis

Coast Guard presence in the proposed action areas is important to enforce environmental and safety regulations, to provide search and rescue, and to assist in maintaining the U.S. Arctic sovereignty (U.S. Coast Guard 2013b; U.S. Navy 2014b). Currently, the main U.S. presence in the Arctic is the Coast Guard, but geopolitical changes may necessitate a greater presence by the U.S. Navy, Army, and Air Force in the future. Military aircraft and vessels, including the Coast Guard's, are currently few in number and generally seasonal in the Arctic; therefore, their addition to cumulative impacts would be minimal.

Compared to the U.S. Air Force's frequent flight operations of large cargo planes, the Coast Guard's vessel, aircraft, and icebreaking operations would add little in the way of air pollution and noise to the Antarctic environment, and would support some of the research projects.

In the Pacific Northwest, there is a continuous military presence by the U.S. Navy, Air Force, Coast Guard, and the Army. The Puget Sound region is home to several U.S. Navy bases, many of which conduct exercises that are part of the U.S. Navy Northwest Training and Testing program. Military aircraft and vessels, including the Coast Guard's, are present year-round in the Pacific Northwest; however, the PIB would only be present in this proposed action area following a dry dock period, before departing for the polar regions of operation; therefore, their addition to cumulative impacts would be minimal.

5.4.13 Community Development Projects (Arctic, Antarctic, and Pacific Northwest; Past, Present, and Future)

5.4.13.1 Overview

Community development projects involve the construction of airports, docks, harbors, boat ramps, roads, response centers, and schools. These projects could result in construction noise in coastal areas, loss of some nearshore habitat, and increase for marine and aircraft traffic to support construction activities. Marine and air transportation could contribute to noise effects through the disturbance of marine species and impacts to the subsistence harvest.

5.4.13.2 5.1.5.2 Arctic

Multiple companies are installing submarine fiber optic cable in the Arctic to improve communications for remote villages. The Quintillion cable project, which connects several communities from Nome to Oliktuk, from the Bering Sea to the Beaufort Sea, began cable laying in 2016 (Quintillion Subsea Operations 2016a, 2016b). The 1,400-mile (2,253 km) project was completed by the end of 2017. Other cable-laying projects are likely to occur in the foreseeable future. Cable-laying may impact marine species with vessel noise, possible vessel collisions with marine species, and temporary disruption of benthic habitat.

In Nome, the initial planning stages of a port expansion project are underway to increase opportunities for economic development, which began with the U.S. Army Corp of Engineers' Alaska Regional Ports Feasibility study that was paused in 2015 and reinstated on February 2, 2018. The initial feasibility report included dredging Nome's outer harbor, lengthening the port's causeway, and the construction of a new dock at the end of the causeway. In Kotzebue, two projects are in development: (1) the construction of a new access road from Kotzebue to Cape Blossom (on the Baldwin Peninsula) and (2) the expansion of dock capabilities at Cape Blossom through building a barge landing, in order to reduce shipping costs. The Cape Blossom Road project has received a Finding of No Significant Impact and has reached final design.

5.4.13.3 Antarctic

The NSF is permitted to build an ice pier to support vessels to dock and unload at McMurdo station. The pier is approximately 800 ft (244 m) long, 300 ft (91 m) wide and 22 ft (7 m) thick, with a viable service life of three to five years. When the pier is deemed unusable for the following year, all transportable equipment, materials, and debris are removed and the ice pier is towed into the Ross Sea to melt (68 FR

775; January 7, 2003). The Environmental Protection Agency issued a general permit to the NSF for this activity in 2014 for another seven-year period (79 FR 22488; April 22, 2014).

5.4.13.4 Pacific Northwest

In the Pacific Northwest, development projects are somewhat limited onshore by the presence of the Olympic National Park and the small size of the communities on the coast. In addition, the coastal offshore area is mainly dominated by the Olympic Coast National Marine Sanctuary. However, small construction projects to the infrastructure of communities may occur onshore and are likely to occur in the near future.

5.4.13.5 Cumulative Impact Analysis

Coast Guard presence in the proposed action areas is important to enforce environmental and safety regulations, and provide search and rescue. The Coast Guard would not be involved with any cable-laying or construction operations, and the Proposed Action would have little or no effect on the benthic or nearshore habitats, and would not contribute to cumulative impacts to benthic or nearshore habitats. Compared to the number of personal or cargo flights to the remote villages and towns in the Arctic, and small boat operations, the Coast Guard's vessel, aircraft, and icebreaking operations would add little in the way of air pollution and noise to the Arctic environment. In the Pacific Northwest, the Coast Guard PIB would only be present in this proposed action area following a dry dock period, before departing for the Polar Regions of operation; therefore, their addition to cumulative impacts would be minimal. In the Antarctic, the Coast Guard PIB would only be present in this proposed action area to directly support McMurdo station. Any pier construction or removal would be integral to McMurdo station operations.

5.5 CUMULATIVE IMPACT SUMMARY

The Coast Guard's mission to protect living marine resources and the environment, provide law enforcement, conduct search and rescue operations, and train to respond to large oil spills would help to prevent environmental damage and protect the proposed action areas; has beneficial effects in the Arctic, Antarctic, and Pacific Northwest proposed action areas. PIBs may contribute to cumulative effects in the acoustic environment, but the potential impacts to marine species, and their habitat including prey availability/distribution, are expected to be minimal and temporary based on the sound produced by polar icebreaking ships (including icebreaking, small boats, and any associated aircraft operations) when compared to the many vessels and aircraft, as well as commercial, government, and research operations in the proposed action areas analyzed above. Furthermore, the use of the SOPs and BMPs described in Chapter 6 would further reduce any impacts, particularly impacts to marine species, or to sensitive biological and critical habitats. Based on the information and analyses provided above on the past, present, and reasonably foreseeable future actions within the proposed action areas, the Coast Guard has determined that the proposed PIB activities in the Arctic, Antarctic, and Pacific Northwest would not be expected to significantly contribute to the cumulative impacts on marine species, critical habitat, the environment, or socioeconomics (Table 5-2).

5.5.1 Irreversible and Irretrievable Commitment of Resources

Environmental consequences as a result of the Proposed Action are considered minor and temporary in nature. Resources irreversibly committed would be limited to aircraft and vessel fuel. PIB activities would not result in destruction of, long term, or cumulative impacts to environmental resources, including physical, biological, socioeconomic, and cultural resources, to the degree that future use would be limited.

Table 5-2. Potential Cumulative Impacts on Resources from Past, Present, and Future Actions or Stressors within the Proposed Action Areas

Action or Stressor	Time Frame	Resources							
		Physical Environment	Marine Vegetation	Invertebrates	Fish	Essential Fish Habitat	Seabirds	Marine Mammals	Socio-economic
Coast Guard Polar Icebreaker **All Areas** (Vessel and aircraft, icebreaking)	Future	Benefit: Environmental protection, oil spill clean up Low probability of short term benthic disturbance	Benefit: Environmental protection Low probability of short term habitat disturbance	Benefit: Environmental protection Low probability of short term habitat disturbance	Benefit: Environmental protection Low probability of short term acoustic or behavior disturbance	Benefit: Environmental protection Low probability of short term habitat disturbance	Benefit: Environmental protection, oil spill clean up Low probability of short term acoustic and behavior disturbance, vessel collision	Benefit: Environmental protection, oil spill clean up Low probability of short term acoustic and behavior disturbance, vessel collision	Benefit: Environmental protection and Search and Rescue
Whaling **Arctic and Antarctic** (Historic and Modern era)	Past Present Future	No Effect	No Effect	No Effect	No Effect	No Effect	Acoustic and behavior disturbance, vessel collision,	Long Term decreased in populations	Decreased population for tourism and native harvest
Oil and Gas **Arctic** (Vessels, oil spills, exploration, production, and transport)	Past Present Future	Increased turbidity, seafloor disturbance, oil spills	Contamination habitat disturbance, oil spills	Habitat disturbance, oil spills, contamination	Acoustic and behavior disturbance, contamination, prey reduction oil spills	Contamination habitat disturbance	Acoustic and behavior disturbance, contamination, vessel collision, prey reduction	Acoustic and behavior disturbance, contamination, vessel collisions, prey reduction TTS or PTS, habitat disturbance	Habitat destruction, decreased fish catch, oil spills

Action or Stressor	Time Frame	Resources							
		Physical Environment	Marine Vegetation	Invertebrates	Fish	Essential Fish Habitat	Seabirds	Marine Mammals	Socio-economic
Climate Change **All Areas**	Present Future	Increased water temperature and acidification	Increased water temperature habitat loss	Reduction of prey habitat loss	Prey reduction, habitat loss	Prey reduction, habitat loss	Prey reduction, decreased populations, habitat loss	Prey reduction, decreased populations, habitat loss	Distribution of fish altered, flooding of villages, lack of sea ice for hunts
Commercial Fishing **All Areas** (Vessels, nets, trawls, long line)	Past Present Future	Marine debris and discarded gear, benthic habitat disturbance	Habitat disturbance	Decreased populations, behavioral and habitat disturbance	Decreased populations, behavioral and habitat disturbance	Decreased populations, behavioral and habitat disturbance	Vessel collision, prey reduction, entanglement	Vessel collision, prey reduction, entanglement	Increase in jobs and income for villages
Shipping **All Areas** (Vessels, transport, cargo, and tourism)	Past Present Future	Marine debris, pollution, human waste	Habitat disturbance	Pollution , contamination	Acoustic disturbance, pollution, contamination	Pollution, contamination	Acoustic disturbance, vessel collision	Acoustic disturbance, vessel collision	Increase in jobs, delivery of goods and money for villages
Subsistence Harvest/Hunt **Arctic and Pacific Northwest** (Fish, invertebrates, and marine mammals)	Past Present Future	No effect	No Effect	Mortality, decreased populations, behavioral disturbance	Mortality, decreased population, behavioral disturbance	Mortality, decreased populations, behavioral disturbance	Mortality, decreased populations, behavioral disturbance	Mortality, decreased populations, behavioral disturbance	Increase in food and crafts to sell

Action or Stressor	Time Frame	Resources							
		Physical Environment	Marine Vegetation	Invertebrates	Fish	Essential Fish Habitat	Seabirds	Marine Mammals	Socio-economic
Research **All areas** (Vessels, air guns, biology, oceanography, and ecology)	Past Present Future	Benthic disturbance	Habitat disturbance	Behavioral disturbance	Behavioral disturbance	Behavioral disturbance	Behavioral disturbance, vessel collision	Acoustic and behavioral disturbance, vessel collision	Increase in jobs and income for villages
Community Development **Arctic and Pacific Northwest** (Cable laying, infrastructure, improvements)	Past Present Future	Benthic disturbance	Habitat disturbance	Habitat disturbance	Behavioral disturbance, habitat disturbance, pollution	Behavioral disturbance, habitat disturbance, pollution	Acoustic disturbance, vessel collision, behavioral disturbance, pollution	Acoustic and behavioral disturbance, vessel collision, pollution	Increase in jobs and essential infrastructure, access to and from villages
Pollution **All Areas** (Shore run off, at sea disposal)	Past Present Future	Habitat loss	Habitat Disturbance	Prey reduction, disease, habitat loss, contamination	Bio-accumulation, prey reduction, disease, habitat loss	Habitat loss, contamination	Bio-accumulation, prey reduction, disease, habitat loss	Bio-accumulation, prey reduction, disease, habitat loss	Reduction of food sources, disease

Action or Stressor	Time Frame	Resources							
		Physical Environment	Marine Vegetation	Invertebrates	Fish	Essential Fish Habitat	Seabirds	Marine Mammals	Socio-economic
Military and Government **All areas** (Navy transits, exercises, logistics)	Past Present Future	No effect	Habitat disturbance	Acoustic and behavioral disturbance	Acoustic and behavioral disturbance	Habitat disturbance	Habitat disturbance	Behavioral disturbance	Increase in jobs and money for villages

CHAPTER 6 PROTECTIVE MEASURES

Protected marine resource program managers in PACAREA and D11 and D13 currently use a variety of guidance and employ proactive operational measures to help minimize the environmental impacts of Coast Guard vessels and aircraft on MPS and MPAs. Although SOPs and BMPs are established on a vessel-by-vessel basis, SOPs and BMPs currently in use by other icebreaking vessels will likely be used as guidance for those for any new icebreaking vessels. While these are subject to change (given the timeframe until new icebreaking vessels are fully operational), the SOPs and BMPs in use by current icebreakers are as follows:

- Coast Guard Headquarters (HQ), Area, and district operating procedures and directives for Coast Guard vessels and aircraft designed to minimize negative interactions with MPS and within MPAs, including formalized speed and approach guidance around marine mammals.
- Enforcement of the ESA, MMPA, National Marine Sanctuaries Act (NMSA), and other pertinent environmental statutes designed to protect MPS and MPAs.
- Participation in regional multiagency working groups, recovery teams, implementation teams, take reduction teams, sanctuary advisory councils, and task forces.
- Properly training lookouts on marine mammal detection and identification and maintaining those lookouts aboard vessels at all times.
- Establishment of Memoranda of Agreement (MOA) with the National Marine Sanctuaries (NMS) outlining procedures for coordinating enforcement activities.
- Providing routine surveillance of the NMS concurrently with other Coast Guard operations, and providing specific targeted or dedicated law enforcement as appropriate. NMS surveillance and enforcement is incorporated into routine patrol orders where feasible.
- Subject to availability of resources, providing other agencies with platforms to conduct critical MPS research and recovery efforts during stranding and recovery operations.
- Regional Fisheries Training Centers (RFTCs) provide applicable ESA, MMPA, and NMSA enforcement training to Coast Guard personnel supporting the MPS mission.
- Participation in the NMFS Marine Mammal Health and Stranding Response Program
- (MMHSRP) as a Co-Investigator. Via this designation, Coast Guard personnel provide the following support to NMFS: (a) responding to distressed marine mammals, (b) temporary restraint or captivity, (c) disentangling, (d) transporting, (e) attaching tags, and (f) collecting samples.
- Formal guidelines for appropriate disposal of animal carcasses.
- Providing opportunistic marine mammal sighting information to the National Marine Mammal Laboratory (NMML) Platforms of Opportunity Program (POP).

CHAPTER 7 CONSULTATION AND COORDINATION

This section documents how the Coast Guard consulted with government, public, and individual interests during preparation of the PEIS. The principal emphasis of this section is a summary of the public comments that we received on the draft PEIS and our responses to those comments. Other types of information included in this section are:

- results of any consultation with the appropriate Federal Agencies about the possible impacts of the proposal on endangered or threatened plant or animal species
- descriptions of the public participation process, including the details of scoping meetings and public hearings
- listings of the persons or groups that were provided copies of the PEIS

7.1.1 Consultation Process

To comply with section 7 of the ESA, the Coast Guard initiated consultation with the USFWS and NMFS in December 2017 regarding the presence of federally listed and federally proposed species and their habitats that are protected under the ESA, as amended; species that are currently candidates for federal listing under the ESA; state-listed threatened or endangered species; and species otherwise granted special status at the state or federal level (e.g., species protected under the MBTA). In a biological evaluation provided to the USFWS and NMFS, the Coast Guard determined that the Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat of the Steller's eider, spectacled eider, North Pacific right whale, polar bear, Southern Resident killer whale, Steller sea lion, or proposed ring seal critical habitat. No other critical habitat overlaps the proposed action areas; therefore, there will be no effect to critical habitat outside of the Arctic and Pacific Northwest proposed action areas. The Coast Guard has determined, pursuant to section 7 of the ESA and its implementing regulations at 50 CFR Part 402, that the Proposed Action may affect, but is not likely to adversely affect, the ESA-listed bearded seal, blue whale, bocaccio, bowhead whale, Chinook salmon, chum salmon, coho salmon, fin whale, gray whale, humpback whale, leatherback sea turtle, marbled murrelet, North Pacific right whale, Pacific eulachon, polar bear, ringed seal, sei whale, sockeye salmon, Southern Resident killer whale, spectacled eider, sperm whale, short-tailed albatross, steelhead trout, Steller's eider, Steller sea lion, or yelloweye rockfish. Additionally, the Proposed Action would have no effect on North Pacific right whale, polar bear, Southern Resident killer whale, spectacled eider, Steller's eider, or Steller sea lion critical habitat, or proposed ringed seal critical habitat.

During the consultation process, the USFWS and NMFS requested further clarification to which the Coast Guard responded. The USFWS also recommended including further analysis of the northern sea otter. In response to this recommendation, the Coast Guard determined that the Proposed Action may affect, but is not likely to adversely affect the northern sea otter. The Proposed Action would have no effect on the northern sea otter's critical habitat. During the consultation process, the Coast Guard participated in biweekly conference calls with USFWS and NMFS staff. On [INSERT DATE], the Coast Guard received concurrence from NMFS and on [INSERT DATE], the Coast Guard received concurrence from the USFWS.

Placeholder: *This section is incomplete because the Coast Guard has not completed the consultation process. Consultations would be completed before issuance of the Final PEIS.*

7.1.2 Coordination

7.1.2.1 Cooperating Agency

The Coast Guard solicited certain Federal agencies to enter into formal agreement to participate in this PEIS process as a cooperating agency. None of those agencies entered into a formal cooperating agency agreement, but rather participated informally through other regulatory processes.

7.1.2.2 Public Participation Process

Communication methods used by the Coast Guard to distribute the proposed project information to residents of Alaska included: radio, newspapers, fliers, electronic mail, and Web sites. Public presentations of the Proposed Action, and preliminary findings provided at public meetings held in Alaska, were advertised with fliers and newspaper postings, as well as in radio announcements, and social media.

A project website was established to facilitate public input within and outside the Arctic, Antarctic and Pacific Northwest regions (http://www.dcms.uscg.mil/Our-Organization/Assistant-Commandant-for-Acquisitions-CG-9/Programs/Surface-Programs/Polar-Icebreaker/). The scheduling of public meetings was publicized in press releases available on the Coast Guard's website and in the Federal Register Notice (83 FR 18319; 26 April 2018). Public meetings were held in Nome (May 7, 2018), Kotzebue (May 9, 2018), Anchorage (May 11, 2018), and in Utqiagvik (May 14, 2018). A Notice of Availability and request for comments [INSERT DATE] was publicized in the Federal Register Notice [INSERT DATE] to notify the public of the 45-day public review period for the Draft PEIS.

> **Placeholder:** *This section is incomplete because the Coast Guard intends to conduct a 45-day public comment period on the Draft PEIS and will update this section before the Final PEIS is completed.*

7.1.3 Persons or Groups that were provided the PEIS

> **Placeholder:** *This section is incomplete because the Coast Guard intends to conduct a 45-day public comment period on the Draft PEIS and will update this section before the Final PEIS is completed.*

CHAPTER 8 CONCLUSION

The Proposed Action supports the Coast Guard's design and build of up to six polar icebreakers with service design lives of 30 years each. This would provide consistent and reliable Coast Guard presence in the Arctic and Antarctic to fulfill the Coast Guard's missions, guided by the Coast Guard's Arctic Strategy and Arctic Strategy Implementation Plan (with direction from the President of the United States), the National Security Strategy, National Military and Maritime Strategies, National Strategy for the Arctic Region, Arctic Region Policy NSPD 66/HSPD 25, National Strategies for Homeland Security, and Maritime Domain Awareness, National Ocean Policy, and EO 13580.

This PEIS is consistent with the requirements of NEPA (42 U.S.C. 4321) and CEQ regulations for implementing NEPA (40 CFR Part 1500). Coast Guard will issue a Record of Decision once the Final PEIS has been made publicly available for 30 days. Scoping for preparation of the Draft PEIS and public commenting on the Draft PEIS were used to obtain input from stakeholders, including individuals, public interest organizations, governmental agencies, and tribes. This input was used to develop the alternatives and issues analyzed in this PEIS. On the basis of the analyses in this PEIS, the types of impacts that could occur during routine operations and training activities would be similar among the action alternatives. The alternatives principally differ on the basis of vessel acquisition.

The first PIB is expected to be delivered in 2023. The Coast Guard proposes to conduct polar icebreaker operations and training exercises to meet Coast Guard mission responsibilities in the U.S. Arctic and Antarctic regions of operation, as well as to conduct vessel performance testing post-dry dock in the Pacific Northwest. The Proposed Action would be conducted by one or more PIBs, multiple support vessels, aircraft, and personnel deployed throughout the Antarctic and Arctic Regions. Those Proposed Action activities pursue four main objectives: perform Coast Guard missions and activities in the polar regions; advance Arctic maritime domain awareness; broaden partnerships; and enhance and improve preparedness, prevention, and response capabilities.

The Coast Guard evaluated acoustic stressors, including acoustic sources, vessel noise, icebreaking noise, aircraft noise, and gunnery noise. This Coast Guard also evaluated physical stressors of the Proposed Action, including vessel and aircraft movement; icebreaking; and military expended materials. Any potential environmental impacts would be temporary or short term and the Coast Guard's SOPs and BMPs would appropriately and reasonably reduce the potential environmental impacts resulting from the Proposed Action. In the analysis of stressors, it was concluded that the Proposed Action is not likely to significantly impact or result in significant harm to the physical, biological, or socioeconomic environment, including marine vegetation, invertebrates, seabirds, sea turtles, fish, Essential Fish Habitat, marine mammals, and socioeconomic resources. Pursuant to section 7 of the ESA, the Coast Guard determined that the Proposed Action is may affect, but is not likely to adversely affect the following species under NMFS' and the USFWS' jurisdiction: the ESA-listed bearded seal, blue whale, bocaccio, bowhead whale, Chinook salmon, chum salmon, coho salmon, fin whale, gray whale, humpback whale, leatherback sea turtle, marbled murrelet, North Pacific right whale, Pacific eulachon, polar bear, ringed seal, sei whale, sockeye salmon, Southern Resident killer whale, spectacled eider, sperm whale, short-tailed albatross, steelhead trout, Steller's eider, Steller sea lion, or yelloweye rockfish.

Pursuant to section 7 under the ESA, acoustic transmissions, vessel noise, aircraft noise, icebreaking noise, and gunnery noise associated with the Proposed Action would not result in the destruction or adverse modification of federally-designated critical habitat of the Steller's eider, spectacled eider, North Pacific right whale, polar bear, Southern Resident killer whale, Steller sea lion, or proposed ring seal critical habitat. No other critical habitat overlaps the proposed action areas; therefore, there will be no effect to critical habitat outside of the Arctic and Pacific Northwest proposed action areas. Based on the information and analyses included in this PEIS on the past, present, and reasonably foreseeable future actions within the proposed action areas, the Coast Guard has determined that the proposed PIB activities in the Arctic, Antarctic, and Pacific Northwest would not be expected to significantly contribute to the cumulative impacts on marine species, critical habitat, the environment, or socioeconomics.

PIBs may contribute to cumulative effects in the acoustic environment, but the potential impacts to marine species, and their habitat including prey availability/distribution, are expected to be minimal and temporary based on the sound produced by polar icebreaking ships (including icebreaking, small boats, and any associated aircraft operations) when compared to the many vessels and aircraft, as well as commercial, government, and research operations in the proposed action areas analyzed above. Furthermore, the use of the SOPs and BMPs would further reduce any impacts, particularly impacts to marine species, or to sensitive biological and critical habitats. Based on the information and analyses provided above on the past, present, and reasonably foreseeable future actions within the proposed action areas, the Coast Guard has determined that the proposed PIB activities in the Arctic, Antarctic, and Pacific Northwest would not be expected to significantly contribute to the cumulative impacts on marine species, critical habitat, the environment, or socioeconomic resources.

CHAPTER 9 COMPLIANCE WITH OTHER APPLICABLE LAWS, DIRECTIVES, EXECUTIVE ORDERS, AND THE RIGHTS OF FEDERALLY RECOGNIZED TRIBES

This chapter is a summary of the federal, tribal, state, and local statutes and regulations that are potentially applicable to the Proposed Action and Alternatives presented in this PEIS. This list includes statutes and regulations that have been followed and require no further action, as well as those for which permits or authorizations have been, or may be at a future date, requested. Given the time frame between document preparation and when the first new PIB may be operational in 2023, the Coast Guard acknowledges that updates to the information provided in this PEIS may be necessary and would therefore follow appropriate processes to ensure compliance. The list below is not exhaustive as it does not include local laws applicable in or near potential ports of call for a PIB, as specific information on ports of call is unknown at this time. For those resources, which are protected, but are located outside of the Arctic, Antarctic, and Pacific Northwest proposed action areas, but may overlap with potential PIB transit routes, the Coast Guard would ensure compliance with any restrictions that have been placed on vessels, per navigational rules.

In accordance with NEPA and EO 12114, the Coast Guard has prepared this PEIS, assessing the environmental impact of and alternatives to a major federal action that has the potential to significantly affect the environment within the U.S. EEZ and extending to the high seas. The Coast Guard has prepared this PEIS based on international, federal, state, and local laws, statutes, regulations, and policies that are pertinent to the implementation of the Proposed Action (Table 9-1), including the following:

Table 9-1. Applicable Laws, Directives, and Executive Orders

Law or Directive	Compliance with Law or Directive
NEPA (42 U.S.C. sections 4321-4370h)	The Coast Guard has prepared this PEIS in accordance with NEPA, as implemented by the CEQ Regulations (40 CFR §§ 1500 *et seq*.).
CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 CFR §§ 1500-1508 *et seq.*)	The Coast Guard has prepared this PEIS in accordance with NEPA, as implemented by the CEQ Regulations (40 CFR §§ 1500 *et seq*.).
EO 12114, Environmental Effects Abroad of Major Federal Actions	The analysis detailed in Section 10-3.19 of Naval Operations (OPNAV) M-5090.1 has been used to determine whether polar icebreaker operations occurring within the U.S. Territorial Sea will have transboundary effects on the environment and this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action.
Chief of Naval Operations Instruction 5090.1D and its accompanying manual	Given the absence of any written Department of Homeland Security policy on how field units are to implement EO 12114, the analysis detailed in Section 10-3.19 of OPNAV M-5090.1 has been used.
Antarctic Conservation Act (16 U.S.C. §§ 2401-2413)	In accordance with the Antarctic Conservation Act, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action.
Antarctic Treaty	Under the Treaty, the Coast Guard must inform other countries of their activities in Antarctica.
Arctic Research and Policy Act (15 U.S.C. §§ 4101-4111)	Research and science activities conducted as a collateral benefit during Coast Guard polar icebreaker operations and training support the Act's goal of conducting basic and applied scientific research in the Arctic. In accordance with ARPA, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action.
Bald and Golden Eagle Protection Act (16 U.S.C. §§ 668-668d)	The Coast Guard determined that the Proposed Action would not result in takes of bald or golden eagles, and, as such, is not required to apply for a permit with the USFWS under the Bald and Golden Eagle Protection Act.
The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Polar icebreaker support of law enforcement activities is considered part of the Proposed Action (e.g., vessel or helicopter activities) and would include implementation of CITES, if applicable. Therefore, no significant impact or harm is expected as a result of the Proposed Action.
Clean Air Act (42 U.S.C. §§ 7401 *et seq.*)	Since air quality in the proposed action areas is not compromised, emissions from the aircraft and vessels associated with the Proposed Action would not constitute a significant impact to the air quality in the proposed action areas. Protocols and equipment incidental to the normal operation of a Coast Guard vessel follow all regulations in order to comply with state and federal laws regarding pollution of air.
Clean Water Act (33 U.S.C. §§ 1251 *et seq*.)	The Coast Guard would follow all existing rules and regulations protecting water quality and the safe handling of any products of the normal operations of the icebreaking vessel including, but not limited to bilge water, ballast water, and wastewater. Protocols and equipment incidental to the normal operation of a Coast Guard vessel follow all regulations in order to comply with state and federal laws regarding pollution of water. As part of the Proposed Action, no additional discharge or substances would enter the

Law or Directive	Compliance with Law or Directive
	water column that is not already accounted for as those that are incidental to the normal operation of a vessel.
Coastal Zone Management Act (16 U.S.C. §§ 1451 *et seq*.)	A Federal agency must determine the impact of the Proposed Action and provide a Coastal Consistency Determination or Negative Determination to the appropriate state agency (e.g., Department of Ecology Washington State) for anticipated concurrence once the homeport is selected for the polar icebreakers.
Endangered Species Act (16 U.S.C. §§ 1531 *et seq*.)	In accordance with the ESA, consultation under section 7 of the ESA was initiated with NMFS and USFWS, for those species under their respective jurisdiction, based on the determination that the Proposed Action may affect, but is not likely to adversely affect the ESA-listed species within the proposed action areas. The Coast Guard determined that the Proposed Action would have no effect and would not destroy or adversely modify critical habitat because none of the proposed activities are expected to result in the destruction or adverse modification of critical habitat. Take of ESA-listed species is not anticipated from the Proposed Action and, therefore, authorization was not warranted or requested. Concurrence was received on [INSERT DATE] from NMFS and [INSERT DATE] from the USFWS.
EO 12088, Federal Compliance with Pollution Control Standards	The Coast Guard would comply with all federal, state, and local pollution control requirements. Therefore, no significant impact or harm is expected as a result of the Proposed Action.
EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations	The Coast Guard has prepared this PEIS to examine the environmental and human health effects of the PIB. As part of the MMPA process, the Coast Guard intends to prepare a Plan of Cooperation (with Alaska Native tribes). To meet the Coast Guard's mission responsibilities in the polar regions, the Coast Guard plans to establish regular and meaningful communication to consult and collaborate with Alaska Natives and tribal officials regarding the Proposed Action. The Coast Guard also would not interfere with a tribe's treaty rights or impinge on access to any area that provides these resources. Therefore, there would be no significant impact or harm to minority and low-income populations from the Proposed Action.
EO 13089, Coral Reef Protection	As part of the Proposed Action and in conjunction with their SOPs and BMPs, the Coast Guard would avoid impacting coral reef habitat and through the Coast Guard's mission, would implement measures to reduce negative impacts. Therefore, no significant impact or harm is expected as a result of the Proposed Action.
EO 13158, Marine Protected Areas	As part of the Proposed Action and in conjunction with their SOPs and BMPs, the Coast Guard would avoid impacting Marine Protected Areas and through the Coast Guard's mission, would implement measures to reduce negative impacts. Therefore, no significant impact or harm is expected as a result of the Proposed Action.
EO 13175, Consultation and Coordination with Indian Tribal Governments	As part of the MMPA process, the Coast Guard intends to prepare a Plan of Cooperation (with Alaska Native tribes). To meet the Coast Guard's mission responsibilities in the polar regions, the Coast Guard plans to establish regular and meaningful communication to consult and collaborate with Alaska Natives and tribal officials regarding the Proposed Action. The Coast Guard also would not interfere with a tribe's treaty rights or impinge on access to any area that provides these resources.

Law or Directive	**Compliance with Law or Directive**
EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds	The Coast Guard entered into an agreement with the USFWS in January 2001 (66 FR 3853; January 17, 2001) to strengthen migratory bird conservation through enhanced collaboration between the two agencies.
International Convention for the Prevention of Pollution from Ships	The Coast Guard would follow all existing rules and regulations protecting water quality and the safe handling of any products of the normal operations of the icebreaking vessel. Protocols and equipment incidental to the normal operation of a Coast Guard vessel follow all regulations. As part of the Proposed Action, no additional discharge or substances would enter the water column that is not already accounted for as those that are incidental to the normal operation of a vessel. Therefore, no significant impact or harm is expected as a result of the Proposed Action.
International Maritime Organization (IMO)	As part of the Proposed Action and in conjunction with their SOPs, BMPs, and through the Coast Guard's mission, the Coast Guard would implement measures to reduce negative impacts; therefore no significant impact or harm is expected as a result of the Proposed Action.
Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (16 U.S.C. §§ 1801 *et seq.*)	The Coast Guard is not requesting Magnuson-Stevens Act consultation at this time, because the Proposed Action discussed in this PEIS includes new icebreakers that are scheduled to begin on-the-water activities as soon as 2023; however, this PEIS may contain information relevant and applicable to support future Coast Guard consultations on Essential Fish Habitat as required under the Magnuson-Stevens Act.
Marine Mammal Protection Act (16 U.S.C. §§ 1361 *et seq.*)	In accordance with the MMPA, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. The Coast Guard is not requesting authorizations under Section 101(a)(5) of the MMPA at this time, because the Proposed Action discussed in this PEIS would not deliver the first operational icebreaker until 2023; however, this PEIS may contain information relevant and applicable to assist with future Coast Guard consultations that are in support of a request for future incidental take authorizations under the MMPA.
Migratory Bird Treaty Act (16 U.S.C. §§ 703-712)	Many of the Coast Guard's missions provide either direct or indirect benefit to migratory birds either through protection to the birds themselves or through protection of their habitat. The Coast Guard has determined that the Proposed Action would not result in a significant adverse effect on a population of migratory bird species and therefore, is not required to consult with the USFWS under the MBTA.
National Historic Preservation Act (54 U.S.C. §§ 306108 *et seq.*)	The National Historic Preservation Act applies to cultural resources evaluated in this PEIS; however, no effects to historic properties are anticipated as a result of the Proposed Action. Therefore, a Section 106 Permit is not required under the National Historic Preservation Act.
National Marine Sanctuaries Act (i.e., Title III of the Marine Protection, Research and Sanctuaries Act of 1972, 33 U.S.C §§ 1401 *et seq.*)	The Coast Guard has determined that the Proposed Action would not destroy, cause the loss of, or injure any sanctuary resource in any National Marine Sanctuary and therefore, is not required to consult with the Secretary under the NMSA.
The Rights of Federally Recognized Tribes	The Coast Guard would not interfere with a tribe's treaty rights (the right of hunting, fishing, gathering, and grazing at usual and accustomed grounds) or impinge on access to any area that provides these resources.

9.1 NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act (42 U.S.C. §§ 4321 *et seq*.) was enacted to provide for the consideration of environmental factors in Federal agency planning and decision making. Federal agencies implement NEPA through CEQ regulations as well as agency-specific regulations and guidance. The first step in the NEPA process is to prepare and publish a Notice of Intent (83 FR 18319; 26 April 2018) to engage the public and initiate the scoping process. Scoping is an early and open process to determine how the lead Federal agency will analyze the potential impacts of a Proposed Action to the human environment, which includes the physical, biological, and socioeconomic resources. This process identifies and defines issues pertaining to a set of reasonable alternatives regarding a Proposed Action. This draft PEIS will be made publicly available and all comments will be addressed in a final draft. A Record of Decision will then be issued by the appropriate Coast Guard official.

9.2 EXECUTIVE ORDER 12114

Executive Order 12114 (44 FR 1957), *Environmental Effects Abroad of Major Federal Actions*, directs Federal agencies to be informed of and take account of environmental considerations when making decisions regarding major Federal actions outside of the United States, its territories, and possessions. Actions with the potential to significantly harm the global commons[14] must be considered. The purpose of EO 12114 is to ensure that environmental factors are weighted equally when compared to other factors in the decision-making process. In Chapter 10 of the Department of Navy Environmental Readiness Program Manual, Naval Operations (OPNAV) M-5090.1, this analysis is referred to an Overseas Environmental Assessment. Given the absence of any written Department of Homeland Security policy on how field units are to implement EO 12114, the analysis detailed in Section 10-3.19 of OPNAV M-5090.1 has been used to determine whether polar icebreaker operations occurring within the U.S. Territorial Sea will have transboundary effects on the environment and this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action.

9.3 ANTARCTIC TREATY

The Antarctic Treaty was signed in 1959 by the twelve countries (including the United States), active since 1961, and has since been acceded by 53 nations. This treaty oversees most activities in the Antarctic. The Treaty prohibits any military measures, such as the establishment of military bases, but does not prevent the use of military personnel or equipment for scientific research or for peaceful purposes. Under the Treaty, the Coast Guard must inform other countries of their activities in Antarctica. This includes reporting the presence of military personnel or equipment intended to be used for peaceful purposes, the occupation of all stations in Antarctica by U.S. nationals, and the inspections by other parties of U.S. facilities including stations, installations and equipment, and ships and aircraft at discharge or embarkation points. In accordance with the Antarctic Treaty, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. As part of the Proposed Action implementation of SOPs and BMPs, the Coast Guard would also implement measures to reduce negative impacts. Therefore, no significant impact or harm is expected as a result of the Proposed Action.

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[14] The geographic areas outside the jurisdiction of any nation, including the oceans beyond their territorial limits. The United States defines this as 12 nm.

9.4 Antarctic Conservation Act

The Antarctic Conservation Act of 1978 (16 U.S.C. §§ 2401-2413) is a U.S. Federal law that addresses the issue of environmental conservation on the continent of Antarctica. This U.S. law was enacted to implement the Antarctic Treaty environmental protections—to provide conservation and protection of the flora and fauna of Antarctica and the ecosystem they depend on, specifically native mammals, birds, plants, ecosystems, habitats, and Antarctic Specially Protected Areas. Under the Antarctic Conservation Act, it is illegal (without a permit) to take marine mammals and birds, engage in harmful interference, enter Antarctic Specially Protected Areas, introduce species to Antarctica, introduce substances designated as waste, discharge designated waste, import certain Antarctic items into the United States or export them to another country. The Antarctic Conservation Act regulates all U.S. citizens as well as projects or companies originating in the United States. This includes U.S. research groups or cruise ships originating outside of the United States. In accordance with the Antarctic Conservation Act, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. As part of the Proposed Action implementation of SOPs and BMPs, the Coast Guard would also implement measures to reduce negative impacts. Therefore, no significant impact or harm is expected as a result of the Proposed Action.

9.5 Arctic Research and Policy Act

The Arctic Research and Policy Act of 1984, as amended in 1990 (15 U.S.C. §§ 4101–4111), reaffirms that the United States has important security, economic, and environmental interests in developing and maintaining a fleet of icebreakers capable of effectively operating in the heavy ice regions of the Arctic (Section 102). Research and science activities conducted as a collateral benefit during Coast Guard polar icebreaker operations and training support the Act’s goal of conducting basic and applied scientific research in the Arctic. ARPA also established the U.S. Arctic Research Commission. The purpose of the Commission is (1) to establish the national policy, priorities, and goals for a basic and applied scientific research program, (2) to promote Arctic research, to recommend Arctic research policy, and to communicate policy recommendations to the President and Congress, (3) to support cooperation and collaboration throughout the Federal government, (4) to guide the development of Arctic research projects, and (5) to interact with Arctic residents, international Arctic research programs and organizations to assess Arctic research needs (United States Arctic Research Commission 2010). In accordance with the ARPA, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. As part of the Proposed Action and as part the Coast Guard mission, specifically supporting scientific missions, and through implementation of SOPs and BMPs, the Coast Guard would also implement measures to reduce negative impacts. Therefore, no significant impact or harm is expected as a result of the Proposed Action.

9.6 Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (16 U.S.C §§ 668-668d) was enacted in 1940 and prohibits anyone, without a permit issued by the Secretary of the Interior, from “taking” bald eagles, including their parts, nests, or eggs and provides criminal penalties for such acts. The Coast Guard determined that the Proposed Action would not result in takes of bald or golden eagles, and, as such, is not required to apply for a permit with the USFWS under the Bald and Golden Eagle Protection Act.

In accordance with the Bald and Golden Eagle Act, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. The Coast Guard determined that the Proposed Action would not result in takes of bald or golden eagles, and, as such, is not required to apply for a permit with the USFWS under the Bald and Golden Eagle Protection Act.

9.7 Clean Air Act

The purpose of the Clean Air Act (42 U.S.C. §§ 7401–7671q) is to protect public health and welfare by the control of air pollution at its source and set forth primary and secondary National Ambient Air Quality Standards to establish criteria for states to attain, or maintain, these minimum standards. Non-criteria air pollutants that can affect human health are categorized as hazardous air pollutants under section 112 of the Clean Air Act. The U.S. Environmental Protection Agency identified 189 hazardous air pollutants such as benzene, perchloroethylene, and methylene chloride. Section 176(c)(1) of the Clean Air Act, commonly known as the General Conformity Rule, requires federal agencies to ensure that their actions conform to applicable state implementation plans for achieving and maintaining the National Ambient Air Quality Standards for criteria pollutants.

In accordance with the Clean Air Act, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. While the Proposed Action would generate air emissions from both aircraft and vessels, these are few in number, and widespread within the proposed action areas. Air emissions would be minimal and of short-duration, and they would be generated at sea, away from the public. Since air quality in the proposed action areas is not compromised, emissions from the aircraft and vessels associated with the Proposed Action would not constitute a significant impact to the air quality in the proposed action areas. At the proposed level of intensity, emissions from these assets would not result in significant impacts. In addition, the Proposed Action is not subject to the General Conformity Rule because the coastal regions of Alaska and Washington, where aircraft and vessels are operating, are in attainment of the National Ambient Air Quality Standards for criteria pollutants. Protocols and equipment incidental to the normal operation of a Coast Guard vessel follow all regulations in order to comply with state and federal laws regarding pollution of air. Therefore, no significant impact or harm is expected as a result of the Proposed Action.

9.8 Clean Water Act

The Clean Water Act (33 U.S.C §§ 1251 *et seq*.) is the cornerstone of surface water quality protection in the United States. The Clean Water Act does not directly deal with ground water or water quality issues. The statute uses a variety of regulatory and non-regulatory tools to sharply reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the physical, chemical, and biological integrity of the nation's waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water." See the International Convention for the Prevention of Pollution from Ships (MARPOL), Section 9.14.

The Oil Pollution Act (OPA) of 1990 (33 U.S.C. §§ 2701-2761) amended the Clean Water Act and addressed the wide range of problems associated with preventing, responding to, and paying for oil pollution incidents in navigable waters of the United States. It created a comprehensive prevention, response, liability, and compensation regime to deal with vessel and facility oil spills. OPA greatly increased federal oversight of maritime oil transportation, while providing greater environmental safeguards. The Oil Spill Liability Trust Fund administration was delegated to the Coast Guard by Executive Order.

9.9 Coastal Zone Management Act

The Coastal Zone Management Act (16 U.S.C §§ 1451 *et seq*.) was enacted to protect the coastal environment from demands associated with residential, recreational, and commercial uses. The Coastal Zone Management Act provisions encourage states to develop coastal management programs for managing and balancing competing uses of the coastal zone. Each state, in order to receive Federal approval, is required to define the boundaries of the coastal zone, to identify uses of the area to be regulated by the state, the mechanism for controlling such uses, and broad guidelines for priorities of uses within the coastal zone. In accordance with the Coastal Zone Management Act, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. A Federal agency must determine the impact of the Proposed Action and provide a Coastal Consistency Determination or Negative Determination to the appropriate state agency (e.g., Department of Ecology Washington State) for anticipated concurrence once the homeport is selected for the polar icebreakers.

9.10 The Convention on International Trade in Endangered Species of Wild Fauna and Flora

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement between governments. It aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival. CITES is a voluntary international agreement. Participating countries agree to implement CITES; however, it does not take the place of national laws. Rather, it provides a framework to be respected by each country, which has to adopt its own domestic legislation to ensure implementation at the national level. In accordance with the CITES, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. Law enforcement operations are part of the Coast Guard mission. Law enforcement vessel boardings would occur in the Bering Sea and in the open ocean of the Arctic proposed action area. Law enforcement missions, including any polar icebreaker support of law enforcement activities, are covered under Title 14 U.S.C. and 6 U.S.C. § 468. Polar icebreaker support of law enforcement activities is considered part of the Proposed Action (e.g., vessel or helicopter activities) and would include implementation of CITES, if applicable. Therefore, no significant impact or harm is expected as a result of the Proposed Action (see Section 1.5.17 Marine Mammal Protection Act as all marine mammals are protected under CITES).

9.11 Endangered Species Act

The Endangered Species Act of 1973 (16 U.S.C §§ 1531 *et seq.*) provides for the conservation of endangered and threatened species and the ecosystems on which they depend. The ESA defines an endangered species as a species in danger of extinction throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered within the near future throughout all or in a significant portion of its range. The USFWS and NMFS jointly administer the ESA and are responsible for listing species as threatened or endangered and for designating critical habitat for listed species. The ESA allows the designation of geographic areas as critical habitat for threatened or endangered species. section 7(a)(2) requires each federal agency to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a federal agency's action "may affect" a listed species, that agency is required to consult with the service (NMFS or USFWS) that has jurisdiction over the species (50 CFR part 402.14(a)). Consultation will conclude with preparation of a biological opinion that determines whether the federal agency action will jeopardize listed species or adversely modify or destroy critical habitat. An incidental take statement is also included in every biological opinion where take is anticipated. This incidental take statement allows the proposed action to occur without being subject to penalties under the ESA.

In accordance with the ESA, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. In accordance with the ESA, consultation under section 7 of the ESA was initiated with NMFS and USFWS, for those species under their respective jurisdiction, based on the determination that the Proposed Action may affect, but is not likely to adversely affect the following ESA-listed species that fall under NMFS' jurisdiction: Fish- Bocaccio (*Oncorhynchus tshwytscha*), chum salmon (*Oncorhynchus keta*), coho salmon (*Oncorhynchus kisutch*), Pacific eulachon (*Thaleichthys pacificus*), sockeye salmon (*Oncorhynchus nerka*), steelhead trout (*Oncorhynchus mykiss*), yelloweyed rockfish (*Sebastes ruberrimus*); Marine mammals- bearded seal (*Erignathus barbatus*), blue whale (*Balaenoptera musculus*), bowhead whale (*Balaena mysticetus*), fin whale (*Balaenoptera physalus*), gray whale (Western North Pacific DPS; *Eschrichtius robustus*), humpback whale (select DPSs; *Megaptera novaeangliae*), killer whale (Southern Resident killer whale DPS; *Orcinus orca*), North Pacific right whale (*Eubalaena japonica*), sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*), Steller sea lion (Western DPS; *Eumetopias jubatus*); Sea turtles- leatherback sea turtle (*Dermochelys coriacea*); and, those that fall under the USFWS jurisdiction: Birds- marbled murrelet (*Brachyramphus marmoratus*), short-tailed albatross (*Diomedea albatrus*), Steller's eider (*Polysticta stelleri*), spectacled eider (*Somateria fischeri*); Marine mammals- polar bear (*Ursinus ursus*), the candidate species- Pacific walrus (*Odobenus rosmarus divergens*). Although the ringed seal (*Phoca hispida*), under NMFS' jurisdiction, is proposed for listing as threatened under the ESA, it is included in the analysis described in this PEIS. Take of ESA-listed species is not anticipated from the Proposed Action and, therefore, authorization was not warranted or requested. Concurrence was received on [INSERT DATE] from NMFS and [INSERT DATE] from the USFWS (Appendix C).

The Coast Guard determined that the Proposed Action would have no effect and would not destroy or adversely modify critical habitat because none of the proposed action activities are expected to result in the destruction or adverse modification of critical habitat for the leatherback sea turtle, North Pacific right whale, polar bear, Southern resident killer whale, spectacled eider, Steller's eider, Steller sea lion, or the proposed ringed seal critical habitat.

9.12 Executive Order 13098 (U.S. Coral Reef Ecosystem)

Executive Order 13098 is aimed at preserving and protection the biodiversity, health, heritage, and social and economic value of U.S. coral reef ecosystems. These coral reef ecosystems include all "species, habitats, and other natural resources associated with coral reefs in all maritime areas and zones subject to the jurisdiction or control of the U.S. (e.g. Federal, State, territorial, or commonwealth waters)." Federal agencies whose actions affect U.S. coral reef ecosystems (i.e., pollution and sedimentation) are required to implement measures that would reduce negative impacts. In accordance with EO 13098, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. There are five major taxonomic groups of coral in the waters of the proposed action areas, specifically in Alaskan waters, and in others areas that the vessel may overlap with while in transit. As part of the Proposed Action and in conjunction with their SOPs and BMPs, the Coast Guard would avoid impacting coral reef habitat and through the Coast Guard's mission, would implement measures to reduce negative impacts. Therefore, no significant impact or harm is expected as a result of the Proposed Action.

9.13 Executive Order 13158 (Marine Protected Areas)

Executive Order 13158 (65 FR 34909) was authorized in May 2000 to protect special natural and cultural resources by strengthening and expanding the nation's system of marine protected areas. The purpose of the order is to (1) strengthen the management, protection, and conservation of existing marine protected areas and establish new or expanded marine protected areas; (2) develop a scientifically based, comprehensive national system of marine protected areas representing diverse U.S. marine ecosystems and the nation's natural and cultural resources; and (3) avoid causing harm to marine protected areas through federally conducted, approved, or funded activities. In accordance with EO 13158, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. As part of the Proposed Action and in conjunction with their SOPs and BMPs, the Coast Guard would avoid Marine Protected Areas and through the Coast Guard's mission, would implement measures to reduce negative impacts, therefore no significant impact or harm is expected as a result of the Proposed Action.

9.14 International Convention for the Prevention of Pollution from Ships

The International Convention for the Prevention of Pollution from Ships is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. The Convention, known as MARPOL 73/78 includes regulations aimed at preventing and minimizing pollution from ships - both accidental pollution and that from routine operations. MARPOL specifies standards for stowing, handling, shipping, and transferring pollutant cargoes, as well as standards for discharge of ship-generated operational wastes. Although the United States has not ratified all components of the Convention, equivalent regulations for the treatment and discharge standards of shipboard sewage exist in amendments of the Clean Water Act (see Section 1.5.8) (the Federal Water Pollution Control Act implemented by 33 U.S.C. 1251 and 33 CFR 159). In accordance with the MARPOL, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. The Coast Guard would follow all existing rules and regulations protecting water quality and the safe handling of any products of the normal operations of the icebreaking vessel. Protocols and equipment incidental to the normal operation of a Coast Guard vessel follow all regulations as discussed under Section 1.5.8. As part of the Proposed Action, no additional discharge or substances would enter the water column that is not already accounted for as those that are incidental to the normal operation of a vessel. Therefore, no significant impact or harm is expected as a result of the Proposed Action.

9.15 International Maritime Organization

The International Maritime Organization (IMO) is a specialized agency of the United Nations responsible for improving the safety and security of international shipping and preventing pollution from ships. It is also involved in legal matters, including liability and compensation issues and the facilitation of international maritime traffic. The IMO concentrates on keeping legislation up to date and ensuring that it is ratified by as many countries as possible and ensuring that these conventions and other treaties are properly implemented by the countries that have accepted them. In accordance with the IMO, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. As part of the Proposed Action and in conjunction with their SOPs, BMPs, and through the Coast Guard's mission, the Coast Guard would also implement measures to reduce negative impacts, therefore no significant impact or harm is expected as a result of the Proposed Action.

9.16 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. Sections 1801–1882), enacted in 1976 and amended by the Sustainable Fisheries Act in 1996, mandates identification and conservation of essential fish habitat. Essential fish habitat is defined as those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity (i.e., full life cycle). These waters include aquatic areas and their associated physical, chemical, and biological properties used by fish, and may include areas historically used by fish. Substrate types include sediment, hard bottom, structures underlying the waters, and associated biological communities. Federal agencies are required to consult with NMFS and to prepare an essential fish habitat assessment if potential adverse effects on essential fish habitat are anticipated from their activities. Any Federal agency action that is authorized, funded, undertaken, or proposed to be undertaken that may affect fisheries is subject to this Act. In addition, Federal agencies shall consult with the Secretary of Commerce with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any essential fish habitat identified under this act.

In accordance with the Magnuson-Stevens Act, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. The Coast Guard is not requesting Magnuson-Stevens Act consultation at this time, because the Proposed Action discussed in this PEIS concluded that based on the best available information, no effects to EFH are anticipated. However, since the first new PIB is scheduled to be delivered in 2023; this PEIS may contain information relevant and applicable to support future Coast Guard consultations on EFH as required under the Magnuson-Stevens Act, particularly as new information is obtained.

9.17 MARINE MAMMAL PROTECTION ACT

The Marine Mammal Protection Act (16 U.S.C §§ 1361 *et seq*.) established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction, and on the high seas by vessels or persons under U.S. jurisdiction. The MMPA further regulates "takes" of marine mammals in U.S. waters and by U.S. citizens on the high seas. The term "take," as defined in Section 3 (16 U.S.C. § 1362) of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal". "Harassment" was further defined in the 1994 amendments to the MMPA as any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A Harassment); or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B Harassment). In the case of a scientific research activity conducted by or on behalf of the Federal

Government, consistent with Section 1374 (c)(3) of this title, the term "harassment" means (i) any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild (Level A Harassment); or (ii) any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered (Level B Harassment; 16 U.S.C § 1362 (18)(b)).

The MMPA directs the Secretary of Commerce, as delegated to NMFS, and the Secretary of the Interior, as delegated to the USFWS, to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens or agencies who engage in a specified activity (other than commercial fishing) within a specified geographical region if NMFS or the USFWS finds that the taking will have a negligible impact on the species or stock(s), and will not have an unmitigatable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant). The regulation must set forth the permissible methods of taking, other means of effecting the least practicable adverse impact on the species or stock and its habitat and on the availability of the species or stock for subsistence uses (where relevant), and requirements pertaining to monitoring and reporting of such taking.

In order to issue an MMPA authorization, if required for the Proposed Action, it may be necessary for NMFS or the USFWS to require additional mitigation or monitoring measures beyond those addressed in this PEIS. These could include measures considered, but eliminated in the PEIS, or as yet undetermined measures. The public would have an opportunity to provide information to NMFS and the USFWS through the MMPA process during the 30-day comment period following NMFS' or the USFWS' publication of a Notice of Availability of a Proposed Incidental Harassment Authorization or Letter of Authorization in the *Federal Register*. Measures not considered in the mitigation and monitoring measures in this PEIS, but required through the MMPA process, might require evaluation in accordance with NEPA. In doing so, NMFS or the USFWS may consider "tiering," that is, incorporating this PEIS or any supplemental environmental assessments, during the MMPA process.

In accordance with the MMPA, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. The Coast Guard is not requesting authorizations under Section 101(a)(5) of the MMPA at this time, because the Proposed Action discussed in this PEIS would not deliver the first operational icebreaker until 2023; however, this PEIS may contain information relevant and applicable to assist with future Coast Guard consultations that are in support of a request for future incidental take authorization under the MMPA. As part of the MMPA, the Coast Guard intends to prepare a Plan of Cooperation that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses.

9.18 Migratory Bird Treaty Act and Executive Order 13186

The Migratory Bird Treaty Act of 1918 (16 U.S.C §§ 703-712 *et seq*.) was enacted to ensure the protection of shared migratory bird resources. The MBTA makes it illegal to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to Federal regulations.

EO 13186, titled “Responsibilities of Federal Agencies to Protect Migratory Birds,” requires all Federal agencies with activities that have (or may have) negative effects on migratory birds to develop, implement, and publish a Memorandum of Understanding with the USFWS that promotes conservation of migratory birds. The Coast Guard entered into such an agreement in January 2001 (66 FR 3853; January 17, 2001) to strengthen migratory bird conservation through enhanced collaboration between the Coast Guard and the USFWS. In December 2017, a Department of Interior legal opinion (Opinion M-37050) stated that the MBTA does not prohibit incidental take. However, the Coast Guard will continue to analyze potential impacts to migratory birds and consult with USFWS when a proposed action may result in an incidental take.

Many of the Coast Guard’s missions provide either direct or indirect benefit to migratory birds either through protection to the birds themselves or through protection of their habitat. The Coast Guard considers the potential environmental effects of its actions to assess the potential of adverse effects from activities on migratory birds. Should the Coast Guard determine that the Proposed Action may result in a significant adverse effect[15] to a population of migratory bird species, the Coast Guard shall consult with the USFWS to develop and implement appropriate conservation measures to minimize or mitigate these effects. In accordance with the MBTA, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. The Coast Guard has determined that the Proposed Action would not result in a significant adverse effect on a population of migratory bird species and therefore, is not required to consult with the USFWS under the MBTA.

9.19 NATIONAL HISTORIC PRESERVATION ACT

The National Historic Preservation Act of 1966 (54 U.S.C. Section 300101 *et seq*.) establishes preservation as a national policy and directs the Federal government to provide leadership in preserving, restoring, and maintaining the historic and cultural environment. Section 106 of the National Historic Preservation Act requires Federal agencies to take into account the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment. The National Historic Preservation Act created the National Register of Historic Places, the list of National Historic Landmarks, and the State Historic Preservation Offices to help protect each state’s historical and archaeological resources. Section 110 of the National Historic Preservation Act requires federal agencies to assume responsibility for the preservation of historic properties owned or controlled by them and to locate, inventory, and nominate all properties that qualify for the National Register. Agencies shall exercise caution to assure that significant properties are not inadvertently transferred, sold, demolished, substantially altered, or allowed to deteriorate. The National Historic Preservation Act applies to cultural resources evaluated in this PEIS; however, no effects to historic properties are anticipated as a result of the Proposed Action. Therefore, a Section 106 Permit is not required under the National Historic Preservation Act.

9.20 NATIONAL MARINE SANCTUARIES ACT

The National Marine Sanctuaries Act (NMSA; also known as Title III of the Marine Protection, Research and Sanctuaries Act of 1972, 33 U.S.C §§ 1401 *et seq*.) authorizes the Secretary of Commerce to designate and manage areas of the marine environment with special national significance due to their

[15] A significant adverse effect on population is defined in 50 CFR § 21.3 as an effect that could, within a reasonable period of time, diminish the capacity of a population of migratory bird species to sustain itself at a biologically viable level.

conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or aesthetic qualities as National Marine Sanctuaries. The primary objective of NMSA is to protect marine resources and areas of special national significance, such as coral reefs, sunken historical vessels, or unique habitats. This Act also directs the Secretary to facilitate all public and private uses of those resources that are compatible with the primary objective of resource protection. Sanctuaries are managed according to site-specific Management Plans prepared by NOAA's National Marine Sanctuary Program. Any Federal agency internal or external to a national marine sanctuary, including private activities authorized by licenses, leases, or permits, that are likely to destroy, cause the loss of, or injure any sanctuary resource are subject to consultation with the Secretary. In accordance with the NMSA, applicable regulations, and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact or environmental harm from the Proposed Action. The Coast Guard has determined that the Proposed Action would not destroy, cause the loss of, or injure any sanctuary resource in any National Marine Sanctuary and therefore, is not required to consult with the Secretary under the NMSA.

9.21 The Rights of Federally Recognized Tribes (Indian and Alaska Native)

Over the course of American history, the U.S. federal government's relationship with Indian tribes has been defined and modified by treaties, executive orders, court decisions, Congressional legislation, and regulations. The U.S. federal government recognizes tribal nations as "domestic dependent nations" and has established laws attempting to clarify the relationship between the federal government, state, and tribal governments. Important rights were guaranteed to tribes by treaty. Case law has established the status of Indian Tribes and their relationship to the federal government. Historically, legislation passed by Congress reflects the national Indian policy at the time of enactment. Current federal Indian policy recognizes that Indian tribes are an integral part of the fabric of the United States, and the policy seeks to strengthen tribal governments through self-determination and self-governance.

The U.S. Supreme Court first recognized the existence of a Federal-Indian trust relationship in cases in the mid-1900s interpreting Indian treaties. Between 1787 and 1871, the United States entered into nearly 400 treaties with Indian tribes. In these treaties, the United States obtained land from the tribes, and in return, the United States set aside other reservation lands for those tribes, and guaranteed that the federal government would respect the sovereignty of the tribes, would protect the tribes, and would provide for the well-being of the tribes. The Supreme Court, in its role as the United States' highest arbiter of justice, upholds tribal rights and obligates the federal government to abide by their agreement with tribes made in the treaties. This principle, that the government has a duty to keep its word and fulfill its treaty commitments is known as the "doctrine of trust" responsibility. The purpose behind the doctrine of trust is, and always has been, to ensure the survival and welfare of Indian tribes and people, including an obligation to provide services required to protect and enhance tribal lands, resources, and self-government, and also includes economic and social programs which are necessary to raise the standard of living and social well-being of the Indian people to a level comparable to the non-Indian society.

The federal trust responsibility extends to all federal agencies and actions, and treaty rights are not diminished by the passage of time. "Express treaty rights" include hunting, fishing, gathering, and grazing rights. "Implied rights" include rights such as, the right to access the areas holding a resource of interest, such as fish or medicinal plants, which would be required to make express treaty rights meaningful. The Fifth Amendment of the U.S. Constitution provides that Congress may not deprive anyone of "private property…without just compensation." The Supreme Court has upheld that Indian treaty rights are a form of private property protected by the Just Compensation Clause[16]. Therefore, although Congress may repeal an Indian treaty, it must adequately compensate a tribe for the value of any rights or property that are lost.

The right of hunting, fishing, gathering, and grazing at usual and accustomed grounds is secured to federally recognized tribes. A federally recognized tribe is an American Indian or Alaska Native tribal entity that is recognized as having a government-to-government relationship with the United States, with the responsibilities, powers, limitations, and obligations attached to that designation. Furthermore, federally recognized tribes are recognized as possessing certain inherent rights of self-government (i.e., tribal sovereignty) and are entitled to receive certain federal benefits, services, and protections due to their special relationship with the United States. At present, 229 of the 573 federally recognized tribes are Alaska Native tribes or villages.

EO 13175 was released in November of 2000 to establish regular and meaningful consultation and collaboration with tribal officials in the development of federal policies that have tribal implications, strengthen the U.S. government-to-government relationships with Indian tribes, and reduce the imposition of unfunded mandates upon Indian tribes. The National Historic Preservation Act, ARPA, ESA, MMPA, EO 13007 (Indian Sacred Sites), EO 12898 (Environmental Justice), Native American Graves Protection and Repatriation Act, American Indian Religious Freedom Act, and the Religious Freedom Restoration Act also apply to tribes and are considered under NEPA.

In accordance with NEPA and the Department of Homeland Security and Coast Guard instructions and directives, this PEIS evaluates the potential for significant impact and significant harm from the Proposed Action. As part of the MMPA process (see Section 1.5.17), the Coast Guard intends to prepare a Plan of Cooperation. To meet the Coast Guard's mission responsibilities in the polar regions, the Coast Guard plans to establish regular and meaningful communication to consult and collaborate with Alaska Natives and tribal officials regarding the Proposed Action. The Coast Guard would not interfere with a tribe's treaty rights or impinge on access to any area that provides these resources.

[16] Just Compensation Clause: Clause in the Fifth Amendment to the United States Constitution that provides "…nor shall private property be taken for public use, without just compensation…"

CHAPTER 10PREPARERS OF THE DOCUMENT

Name	Qualifications
U.S. Navy	
Monica DeAngelis	M.S. in Biology. 24 years marine mammal research; 18 years environmental planning experience.
Jocelyn Borcuk	B.S. in Marine Biology. 2 years marine mammal modeling experience; 6 years environmental planning experience.
Erica Felins	M.S. in Environmental Science and Management. 3 years biological research; 1 year environmental planning experience.
Sarah Blackstock	M.S. in Oceanography. 2 years modeling and prototype experience.
McLaughlin Research Corporation	
Kelsey Brown	B.S. in Applied Mathematics and B.S. in Marine Biology. 3 years editing experience; 1 year environmental planning experience.
Jason Krumholz	Ph.D. in Oceanography. 13 years research experience; 2 years environmental planning experience
Erin Oliveira	B.S. in Marine Biology. 3 years environmental research experience; 7 years environmental planning experience.

CHAPTER 11 REFERENCES

Acevedo, A. (1991). Interactions between boats and bottlenose dolphins, Tursiops truncatus, in the entrance to Ensenada De La Paz, Mexico. *Aquatic Mammals, 17.3*, 120-124.

Adams, A. J., Locascio, J. V., & Robbins, B. D. (2004). Microhabitat use by a post-settlement stage estuarine fish: Evidence from relative abundance and predation among habitats. *Journal of Experimental Marine Biology and Ecology, 299*(1), 17-33. doi: 10.1016/j.jembe.2003.08.013.

Adams, P. B., Botsford, L. W., Gobalet, K. W., Leidy, R. A., McEwan, D. R., Moyle, P. B., . . . Yoshiyama, R. M. (2007). Coho Salmon are Native South of San Francisco Bay: A Reexamination of North American Coho Salmon's Southern Range Limit. *Fisheries, 32*(9), 441-451. doi: 10.1577/1548-8446(2007)32[441:CSANSO]2.0.CO;2.

AECOM. (2013). *Essential Fish Habitat Assessment Port Costa Wharf Deconstruction Project Porta Costa, California*. Oakland, CA: AECOM. p. 34.

Aerts, L. A., McFarland, A. E., Watts, B. H., Lomac-MacNair, K. S., Seiser, P. E., Wisdom, S. S., . . . Schudel, C. A. (2013). Marine mammal distribution and abundance in an offshore sub-region of the northeastern Chukchi Sea during the open-water season. *Continental Shelf Research, 67*, 116-126.

Ainley, D. G., Allen, S. G., & Spear, L. B. (1995). Offshore occurrence patterns of marbled murrelets in central California. In. Ralph Jr., C. L., Hunt, G. L., Raphael, M. G. & Piatt, J. F. (Eds.), *Ecology and conservation of the marbled murrelet* (pp. 361-369). Albany, CA: Forest Service General Technical Report PSW-152.

Ainley, D. G., Ballard, G., & Weller, J. (2010a). *Ross Sea Bioregionalization Part I: Validation of the 2007 CCAMLR Bioregionalization Workshop Results Towards Including the Ross Sea in a Representative Network of Marine Protected Areas in the Southern Ocean.* Hobart: CCAMLR. pp. 1-61.

Ainley, D. G., O'Connor, E. F., & Boekelheide, R. J. (1984). The Marine Ecology of Birds in the Ross Sea, Antarctica. *Ornithological Monographs*(32), iii-97. doi: 10.2307/40166773.

Ainley, D. G., & Pauly, D. (2014). Fishing down the food web of the Antarctic continental shelf and slope. *Polar Record, 50*(01), 92-107.

Ainley, D. G., Russell, J., Jenouvrier, S., Woehler, E. J., Lyver, P. O., Fraser, W., & Kooyman, G. L. (2010b). Antarctic pengiun response to habitat change as Earth's troposphere reaches 2C above preindustrial levels. *Ecological Monographs, 80*(1), 49-66. doi: doi:10.1890/08-2289.1.

Airame, S., Gaines, S., & Caldow, C. (2003). Ecological linkages: Marine and estuarine ecosystems of central and northern California.

Alan, E. B., Christine, L. H., & Gail, K. D. (2004). Spatial aggregations of seabirds and their prey on the continental shelf off SW Vancouver Island. *Marine Ecology Progress Series, 283*, 279-292.

Alaska Department of Fish and Game. (2011). Subsistence in Alaska Retrieved from http://www.adfg.alaska.gov/index.cfm?adfg=subsistence.definition as accessed on June 20, 2018.

Alaska Department of Fish and Game. (2017a). Alaska Sport Fishing Survey Retrieved from http://www.adfg.alaska.gov/sf/sportfishingsurvey/index.cfm?ADFG=region.results as accessed on 15 March 2017.

Alaska Department of Fish and Game. (2017b). Commercial Fishing by Area Retrieved from http://www.adfg.alaska.gov/index.cfm?adfg=fishingcommercialbyarea.interior as accessed on 15 March 2017.

Alaska Department of Fish and Game. (2017c). Commerical Salmon Fisheries Retrieved from http://www.adfg.alaska.gov/index.cfm?adfg=CommercialByFisherySalmon.main as accessed on 15 Mar 2017.

Alaska Department of Fish and Game. (2017d). Green Sea Turtle (Chelonia mydas) Species Profile Retrieved from http://www.adfg.alaska.gov/index.cfm?adfg=greenseaturtle.main as accessed on 1 May 2017.

Alaska Department of Fish and Game. (2017e). Ice Seal Research Projects Retrieved from http://www.adfg.alaska.gov/index.cfm?adfg=marinemammalprogram.icesealresearch as accessed on 06 March 2017.

Alaska Department of Fish and Game. (2017f). Leatherback Sea Turtle (Dermochelys coriacea) Species Profile. Retrieved from http://www.adfg.alaska.gov/index.cfm?adfg=leatherbackseaturtle.main as accessed on 1 May 2017.

Alaska Department of Fish and Game. (2017g). Loggerhead Sea Turtle (Caretta caretta) Species Profile. Retrieved from http://www.adfg.alaska.gov/index.cfm?adfg=loggerheadseaturtle.main as accessed on 1 May 2017.

Alaska Department of Fish and Game. (2017h). Olive Ridley Sea Turtle (Lepidochelys olivacea) Species Profile. Retrieved from http://www.adfg.alaska.gov/index.cfm?adfg=oliveridleyseaturtle.main as accessed on 1 May 2017.

Alaska Department of Fish and Game. (2017i). Red King Crab (*Paralithodes camtschaticus*) Species Information Retrieved from http://www.adfg.alaska.gov/index.cfm?adfg=redkingcrab.main as accessed on 17 April 2017.

Alaska Department of Fish and Game. (2017j). Steller's Eider (Polysticta stelleri) Species Profile. Retrieved from http://www.adfg.alaska.gov/index.cfm?adfg=stellerseider.main as accessed on 25 April 2017.

Alaska Shorebird Group. (2016). Annual Summary Compilation: New or ongoing studies of Alaska shorebirds. Available at https://www.fws.gov/alaska/mbsp/mbm/shorebirds/pdf/2016_ASG_annual_summaries.pdf as accessed on 19 July 2017 Retrieved

Alerstam, T., Bäckman, J., Gudmundsson, G. A., Hedenström, A., Henningsson, S. S., Karlsson, H., . . . Strandberg, R. (2007). A polar system of intercontinental bird migration. *Proceedings of the Royal Society B: Biological Sciences, 274*(1625), 2523-2530. doi: 10.1098/rspb.2007.0633.

Alerstam, T., & Gudmundsson, G. A. (1999a). Bird orientation at high latitudes: flight routes between Siberia and North America across the Arctic Ocean. *Proceedings of the Royal Society B: Biological Sciences, 266*(1437), 2499-2505.

Alerstam, T., & Gudmundsson, G. A. (1999b). Migration patterns of tundra birds: Tracking radar observations along the Northeast Passage. *Arctic, 52*(4), 346-371.

Alerstam, T., Gudmundsson, G. A., & Larsson, B. (1993). Flight tracks and speeds of Antarctic and Atlantic seabirds: Radar and optical measurements. *Philosophical Transactions of the Royal Society of London, 340*, 55-67.

Allen, J. A. (1880). *History of North American pinnipeds: a monograph of the walruses, sea-lions, sea-bears and seals of North America*. U.S. Government Printing Office, Washington, D.C.: U.S. Department of the Interior. p. 785.

Allen, M. J., & Smith, G. B. (1988). Atlas and zoogeography of common fishes in the Bering Sea and northeastern Pacific.

Allen, S. G., Ainley, D. G., Page, G. W., & Ribic, C. A. (1984). The effect of disturbance on harbor seal haul out patterns at Bolinas Lagoon, California. *Fisheries Bulletin, 82*, 493-499.

AMAP. (2017). *Snow, Water, Ice and Permafrost in the Arctic (SWIPA) 2017*. (8279711015). Oslo, Norway: Arctic Monitoring and Assessment Programme (AMAP). p. 269.

American Association of Port Authorities. (2015). U.S. Port Rankings by Cargo Tonnage 2015. Retrieved from http://www.aapa-ports.org/unifying/content.aspx?ItemNumber=21048#Statistics as accessed on 12 May 2017.

American Association of Port Authorities. (2016a). North American Contianer Traffic: 2015 Port Rankings Retrieved from http://www.aapa-ports.org/unifying/content.aspx?ItemNumber=21048#Statistics as accessed on 12 May 2017.

American Association of Port Authorities. (2016b). U.S. Waterborne Foreign Trade 2016 by Customs District. Retrieved from http://www.aapa-ports.org/unifying/content.aspx?ItemNumber=21048#Statistics as accessed on 15 May 2017.

American National Standards Institute (ANSI). (2001). Design Response of Weighting Networks for Acoustical Measurements. *Acoustical Society of America, ANSI S1.42-2001* 14.

Amoser, S., & Ladich, F. (2005). Are hearing sensitivities of freshwater fish adapted to the ambient noise in their habitats? *The Journal of Experimental Biology, 208*, 3533-3542.

Amstrup, S., & DeMaster, D. P. (1988). Polar Bear, Ursus maritimus. In. Lantfer, J. W. (Ed.), *Selected Marine Mammals of Alaska: Species Accounts with Research and Management Recommendations* (pp. 39-56). Washington, DC: Marine Mammal Commission.

Amstrup, S. C. (1993). Human disturbances of denning polar bears in Alaska. *Arctic*, 246-250.

Amstrup, S. C. (1995). *Movements, distribution, and population dynamics of polar bears in the Beaufort Sea*. Fairbanks, AK: University of Alaska Fairbanks. p. 299.

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.

Amstrup, S. C., Durner, G. M., Stirling, I., & McDonald, T. L. (2005). Allocating harvests among polar bear stocks in the Beaufort Sea. *Arctic, 58*, 247-259.

Amstrup, S. C., & Gardner, C. (1994). Polar bear maternity denning in the Beaufort Sea. *The Journal of Wildlife Management, 58*(1), 1-10.

Amstrup, S. C., Stirling, I., & Lentfer, J. W. (1986). Past and present status of polar bears in Alaska. *Wildlife Society Bulletin (1973-2006), 14*(3), 241-254.

Anderson, B. A., Johnson, C. B., Cooper, B. A., Smith, L. N., & Stickney, A. A. (1999). Habitat associations of nesting spectacled eiders on the Arctic coastal plain of Alaska. In *Behavior and ecology of sea ducks* (pp. 27-33). Canada, Ottawa: Canadian Wildlife Service and the Pacific Seabird Group.

Anderson, J. B., Brake, C. F., & Myers, N. C. (1984). Sedimentation on the Ross Sea Continental Shelf, Antarctica. *Marine Geology, 57*, 295-333. doi: 10.1016/0025-3227(84)90203-2.

Andrew, R. K., Howe, B. M., & Mercer, J. A. (2011). Long-time trends in ship traffic noise for four sites off the North American West Coast. *Journal of the Acoustical Society of America, 129*, 642-651.

Andrews, R. C. (1916). *The Sei Whale Balaenoptera Borealis Lesson: 1. History, Habits, External Anatomy, Osteology, and Relationships. By Roy Chapman Andrews*: Museum.

Angell, C. M. (2006). Body fat condition of free-ranging right whales, Eubalaena glacialis and Eubalaena australis. *Boston University*.

Antarctic and Southern Ocean Commission (ASOC). (2008, 2-13 June, 2008). *Impacts of Climate Change on Antarctic Ecosystems.* Paper presented at the XXXI Antarctic Treaty Consultative Meeting, Kiev, Ukraine.

Antarctic Treaty Secretariat. (2017). The Madrid 1998 Environmental Protocol Retrieved from http://www.ats.aq/index_e.htm as accessed on 28 February 2017.

Arctic Council. (2004). *Arctic Climate Impact Assessment (ACIA): Impacts of a Warming Arctic*.

Arctic Council. (2009). *Arctic Marine Shipping Assessment 2009 Report*. Protection of the Arctic Marine Environment (PAME). p. 189 p.

Arrigo, K. R., Perovich, D. K., Pickart, R. S., Brown, Z. W., van Dijken, G. L., Lowry, K. E., . . . Bahr, F. (2012). Massive phytoplankton blooms under Arctic sea ice. *Science, 336*(6087), 1408-1408.

Arveson, P. T., & Vendittis, D. J. (2000). Radiated noise characteristics of a modern cargo ship. *Journal of the Acoustical Society of America, 107*(1), 118-129.

Ashjian, C. J., Braund, S. R., Campbell, R. G., GEORGE, J. C., Kruse, J., Maslowski, W., . . . Sherr, B. F. (2010). Climate variability, oceanography, bowhead whale distribution, and Iñupiat subsistence whaling near Barrow, Alaska. *Arctic*, 179-194.

Astrup, J. (1999). Ultrasound Detection in Fish - A Parallel to the Sonar-mediated Detection of Bats by Ultrasound-sensitive Insects? *Comparative Biochemistry and Physiology, 124*, 19-27.

Attard, C. R., Beheregaray, L. B., & Möller, L. M. (2016). Towards population-level conservation in the critically endangered Antarctic blue whale: the number and distribution of their populations. *Scientific reports, 6*.

Au, W. W. (1993). Characteristics of dolphin sonar signals. In *The Sonar of Dolphins* (pp. 115-139): Springer.

Au, W. W., Floyd, R. W., Penner, R. H., & Murchison, A. E. (1974). Measurement of echolocation signals of the Atlantic bottlenose dolphin, Tursiops truncatus Montagu, in open waters. *The Journal of the Acoustical Society of America, 56*(4), 1280-1290.

Au, W. W., & Green, M. (2000). Acoustic interaction of humpback whales and whale-watching boats. *Marine Environmental Research, 49*(5), 469-481.

Au, W. W., Pack, A. A., Lammers, M. O., Herman, L. M., Deakos, M. H., & Andrews, K. (2006). Acoustic properties of humpback whale songs. *Journal of the Acoustical Society of America, 120*(2), 1103-1110.

Au, W. W. L., & Hastings, M. C. (2008). *Principles of Marine Bioacoustics*. New York: Springer Science + Business Media, LLC.

Avens, L., & Lohmann, K. J. (2003). Use of multiple orientation cues by juvenille loggerhead sea turtles *Caretta caretta*. *The Journal of Experimental Biology, 206*(23), 4317-4325.

Azzarello, M. Y., & Vleet, E. S. V. (1987). Marine birds and plastic pollution. *Marine Ecology Progress Series, 37*, 295-303.

Babushina, E. S., Zaslavsky, G. L., & Yurkevich, L. I. (1991). Air and underwater hearing of the northern fur seal audiograms and auditory frequency discrimination. *Biofizika, 36*(5), 904-907.

Bachmann, L., Wiig, Ø., Heide-Jørgensen, M. P., Laidre, K. L., Postma, L. D., Dueck, L., & Palsbøll, P. J. (2010). Genetic diversity in Eastern Canadian and Western Greenland bowhead whales (Balaena mysticetus). *Reports of the International Whaling Commission*.

Badino, A., Borelli, D., Gaggero, T., Rizzuto, E., & Schenone, C. (2012). Normative framework for ship noise: Present and situation and future trends. *Noise Control Engineering Journal, 60*(6), 740-762.

Baier, C. T., & Napp, J. M. (2003). Climate-induced variability in Calanus marshallae populations. *Journal of Plankton Research, 25*(7), 771-782.

Bailey, H., Mate, B. R., Palacios, D. M., Irvine, L., Bograd, S. J., & Costa, D. P. (2009). Behavioural estimation of blue whale movements in the Northeast Pacific from state-space model analysis of satellite tracks. *Endangered Species Research, 10*(1-1), 93-106.

Baker, C., & MacGibbon, J. (1991). *Responses of sperm whales Physeter macrocephalus to commercial whale watching boats off the coast of Kaikoura*. Unpublished report to the Department of Conservation, Wellington.

Baker, C. S., & Herman, L. M. (1989). *Behavioral responses of summering humpback whales to vessel traffic: Experimental and opportunistic observations (Megaptera novaeangliae)*. Tech. Rep. No. NPS-NR-TRS-89-01. 50 pgs. Final report to the National Park Service, Alaska Regional Office, Anchorage, Alaska [Available from the U.S. Dept. Interior, NPS, Alaska Reg. Off., Room 107, 2525 Gambell St., Anchorage, AK 99503.

Baker, C. S., Herman, L. M., Bays, B. G., & Bauer, G. B. (1983). *The impact of vessel traffic on the behavior of humpback whales in southeast Alaska: 1982 season*. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, National Marine Mammal Laboratory.

Baker, C. S., Herman, L. M., Perry, A., Lawton, W. S., Straley, J. M., Wolman, A. A., . . . Reinke, J. M. (1986). Migratory movement and population structure of humpback whales (Megaptera novaeangliae) in the central and eastern North Pacific. *Marine Ecology Progress Series*, 105-119.

Ballard, G., Toniolo, V., Ainley, D. G., Parkinson, C. L., Arrigo, K. R., & Trathan, P. N. (2010). Responding to climate change: Adelie Penguins confront astronomical and ocean boundaries. *Ecology, 91*(7), 2056-69.

Barlow, J. (1995). The abundance of cetaceans in California waters. Part I: Ship surveys in summer and fall of 1991. *Fisheries Bulletin, 93*, 1-14.

Barlow, J. (2003). *Preliminary Estimates of the Abundance of Cetaceans Along the US West Coast, 1991-2001*: [US Department of Commerce, National Oceanic and Atmospheric Administration], National Marine Fisheries Service, Southwest Fisheries Science Center.

Barlow, J. (2010). *Cetacean abundance in the California Current estimated from a 2008 ship-based line-transect survey*: US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Barlow, J., & Forney, K. A. (2007). Abundance and population density of cetaceans in the California Current ecosystem. *Fishery Bulletin, 105*(4), 509-526.

Bartol, S. E. M. (1994). *Auditory Evoked Potentials of the Loggerhead Sea Turtle (Caretta caretta).* (masters), College of William and Mary;Marine Science.

Bartol, S. M., & Ketten, D. R. (2006). Turtle and Tuna Hearing. In. Swimmer, Y. & Brills, R. W. (Eds.), *Sea Turtle and Pelagic Fish Sensory Biology: Developing Techniques to Reduce Sea Turtle Bycatch in Longline Fisheries* (pp. 98-103): National Oceanic and Atmospheric Administration.

Bauer, G. B., & Herman, L. M. (1986). *Effects of vessel traffic on the behavior of humpback whales in Hawaii*. Honolulu, National Marine Fisheries Service. pp. 1-151.

Beacham, T. D., Candy, J. R., McIntosh, B., MacConnachie, C., Tabata, A., Kaukinen, K., . . . Varnavskaya, N. (2005). Estimation of stock composition and individual identification of sockeye salmon on a Pacific Rim basis using microsatellite and major histocompatibility complex variation. *Transactions of the American Fisheries Society, 134*(5), 1124-1146.

Beamish, R. J., McFarlane, G. A., & King, J. R. (2005). Migratory Patterns of Pelagic Fishes and Possible Linkages between Open Ocean and Coastal Ecosystems off the Pacific Coast of North America. *Deep-Sea Research II, 52*, 739-755.

Bearzi, G., Politti, E., Agazzi, S., Bruno, S., Costa, M., & Bonizzoni, S. (2005). Occurrence and present status of coastal dolphins (Delphinus delphis and Tursiops truncatus) in the eastern Ionian Sea. *Aquatic Conservation: Marine and Freshwater Ecosystems, 15*, 243-257.

Beason, R. C. (2004). What can birds hear? *USDA National Wildlife Research Center - Staff Publications, Paper 78*, 92-96.

Beauchamp, W. D., Cooke, F., Lougheed, C., Lougheed, L. W., Ralph, C. J., & Courtney, S. (1999). Seasonal Movements of Marbled Murrelets: Evidence from Banded Birds. *The Condor, 101*(3), 671-674. doi: 10.2307/1370198.

Beaulieu, S. E. (2001). Life on Glass Houses: Sponge Stalk Communities in the Deep Sea. *Marine Biology*.

Becker, A., Whitfield, A., Cowley, K., Järnegren, J., & Næsje, T. F. (2013). Does boat traffic cause displacement of fish in estuaries? *Marine Pollution Bulletin, 75*(1), 168-173.

Bedard, J. (1969). Feeding of the least, crested, and parakeet auklets around St. Lawrence Island, Alaska. *Canadian Journal of Zoology, 47*, 1025-1050.

Bejder, L., Samuels, A., Whitehead, H., & Gales, N. (2006). Interpreting short-term behavioural responses to disturbance within a longitudinal perspective. *Animal Behaviour, 72*(5), 1149-1158.

Bengtson, J. L., Boveng, P. L., Hiruki-Raring, L. M., Laidre, K., Pungowiyi, C., & Simpkins, M. A. (2000). *Abundance and distribution of ringed seals (Phoca hispida) in the coastal Chukchi Sea*. (AFSC Processed Rep. 2000-11). Seattle, WA: Alaska Fisheries Science Center (AFSC). pp. 149-160.

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. *28*, 833-845.

Benson, S. R., Eguchi, T., Foley, D. G., Forney, K. A., Bailey, H., Hitipeuw, C., . . . Dutton, P. H. (2011). Large-scale movements and high-use areas of western Pacific leatherback turtles, Dermochelys coriacea. *Ecosphere, 2*(7), 1-27. doi: 10.1890/ES11-00053.1.

Berman-Kowalewski, M., Gulland, F. M., Wilkin, S., Calambokidis, J., Mate, B., Cordaro, J., . . . Fahy, K. (2010). Association between blue whale (Balaenoptera musculus) mortality and ship strikes along the California coast. *Aquatic Mammals, 36*(1), 59.

Berzin, A., & Rovnin, A. (1966). The distribution and migrations of whales in the northeastern part of the Pacific, Chukchi and Bering Seas. *Izvestiya Tikhookeanskogo Nauchno-Issledovatel'skogo Institut Rybnogo Khozyaistva I Okeanografii, 58*, 179-207.

Best, P. B., Brendao, D. S., & Butterworth, D. S. (2005). *Updated estimates of demographic parameters for southern right whales*. presented to the Scientific Committee of the International Whaling Commission.

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

Bettridge, S., Baker, C. S., Barlow, J., Clapham, P. J., Ford, M., Gouveia, D., . . . Silber, G. K. (2015). Status review of the humpback whale (Megaptera novaeangliae) under the Endangered Species Act. *NOAA Technical Memorandum NMFS. NOAA-TM-NMFSSWFSC-540. California: US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center*.

Bickel, S. L., Malloy Hammond, J. D., Tang, K. W. B., Samantha L., Malloy Hammond, J. D., & Tang, K. W. (2011). Boat-generated turbulence as a potential source of mortality among copepods. *Journal of Experimental Marine Biology and Ecology, 401*(1-2), 105-109.

Bigg, M., Olesiuk, P., Ellis, G., Ford, J., & Balcomb, K. (1990). Social organization and genealogy of resident killer whales (Orcinus orca) in the coastal waters of British Columbia and Washington State. *Report of the International Whaling Commission, Special, 12*, 383-405.

Bigg, M. A. (1982). *An assessment of killer whale (Orcinus orca) stocks off Vancouver Island, British Columbia*. pp. 655-666.

BirdLife International. Migratory Birds and Flyways Retrieved from http://www.birdlife.org/worldwide/programme-additional-info/migratory-birds-and-flyways as accessed on 4/6/17.

Birkhead, T. (2013). Bird's Eye View. *Audubon Magazine, May/June 2013*.

Bisby, F. A., Roskov, Y., Culham, A., Orrell, T., Nicolson, D., Paglinawan, L., . . . Ouvrard, D. (Eds.). (2010). *Species 2000 & ITIS Catalogue of Life: 2010 Annual Checklist*. Reading, UK: Species 2000.

Bishop, M. J. B., M. J. (2008). Displacement of epifauna from seagrass blades by boat wake. *Journal of Experimental Marine Biology and Ecology, 354*(1), 111-118.

Black Ball Ferry Line. (2017). This Route Retrieved from https://www.cohoferry.com/The-Route as accessed on 02 May 2017.

Black, N. A. (1997). *Killer whales of California and western Mexico: a catalog of photo-identified individuals* (Vol. 247): US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Blackwell, S. B., & Greene, C. R., Jr. (2006). Sounds from an oil production island in the Beaufort Sea in summer: characteristics and contribution of vessels. *J Acoust Soc Am, 119*(1), 182-96.

Blackwell, S. B., & Greene Jr., C. R. (2005). Underwater and in-air sounds from a small hovercraft. *Journal of the Acoustical Society of America, 118*, 3646-3652.

Blackwell, S. B., Lawson, J. W., & Williams, M. T. (2004). Tolerance by ringed seals (Phoca hispida) to impact pipe-driving and construction sounds at an oil production island. *Journal of the Acoustical Society of America, 115*(5), 2346-2357. doi: 10.1121/1.1701899.

Blair, H. B., Merchant, N. D., Friedlaender, A. S., Wiley, D. N., & Parks, S. E. (2016). Evidence for ship noise impacts on humpback whale foraging behavior. *Biology Letters, 12*. doi: 10.1098/rsbl.2016.0005.

Bluhm, B. A., Gebruk, A. V., Gradinger, R., Hopcroft, R. R., Heuttmann, F., Kosobokova, K. N., . . . Weslawski, J. M. (2011). Arctic marine biodiversity: An update of species richness and examples of biodiversity change. *Oceanography, 24*(3), 232-248. doi: http://dx.doi.org/10.5670/oceanog.2011.75.

Bluhm, B. A., & Gradinger, R. (2008). Regional Variability in Food Availability for Arctic Marine Mammals. *Ecological Applications, 18*(2), S77-S96.

Bocher, P., Yves, C., & Hobson, K. A. (2000). Complete trophic segregation between South Georgian and common diving petrels during breeding at Iles Kerguelen. *Marine Ecology Progress Series, 208*, 249-264.

Bonnell, M. L., Pierso, M. O., & Farrens, G. D. (1983). *Pinnipeds and sea otters of central and northern California, 1980-1983: status, abundance and distribution*. (Final report for contract AA551-CT9-33 to US Department of Interior, Minerals Management Service). Santa Cruz, CA: Center for Marine Studies, University of California. pp. 112-124.

Bonner, W. N. (1986). *Marine mammals of the Falkland Islands*. Cambridge, UK.

Borelli, D., Gaggero, T., Rizzuto, E., & Schenone, C. (2015). Analysis of noise on board a ship during navigation and manoeuvres. *Ocean Engineering, 105*, 256-269.

Born, E. W., Riget, F. F., Dietz, R., & Andriashek, D. (1999). Escape responses of hauled out ringed seals (Phoca hispida) to aircraft disturbance. *Polar Biology, 21*(3), 171-178.

Borsa, P. (2006). Marine mammal strandings in the New Caledonia region, Southwest Pacific. *Comptes Rendus Biologies, 329*(4), 277-288.

Bost, C.-A., Cotté, C., Bailleul, F., Cherel, Y., Charrassin, J.-B., Guinet, C., . . . Weimerskirch, H. (2009). The importance of oceanographic fronts to marine birds and mammals of the southern oceans. *Journal of Marine Systems, 78*(3), 363-376.

Bowen, B. W., Abreu-Grobois, F. A., Balazs, G. H., Kamezaki, N., Limpus, C. J., & Ferl, R. J. (1995). Trans-Pacific migrations of the loggerhead turtle (Caretta caretta) demonstrated with mitochondrial DNA markers. *Proceedings of the National Academy of Sciences of the United States of America, 92*(9), 3731-3734.

Bowles, A. E., Smultea, M., Wursig, B., DeMaster, D. P., & Palka, D. (1994). Relative abundance and behavior of marine mammals exposed to transmissions from the Heard Island Feasibility Test. *Journal of Acoustical Society of America, 96*(4), 2469-2484.
Bowles, A. E., & Stewart, B. S. (1980). *Disturbances to the pinnipeds and birds of San Miguel Island, 1979-1980. Potential effects of space shuttle sonic booms on the biota and geology of the California Channel Islands: Research reports.* .
BP Exploration (Alaska) Inc. (2009). *Taking of Marine Mammals Incidental to Operation of Offshore Oil and Gas Facilities in the U.S. Beaufort Sea (50 C.F.R. Part 216, Subpart R). Permit Application submitted to NMFS OPR.* 113 pp.
Braham, H., & Dahlheim, M. (1981). *Marine Mammal Resource Assessment for the St George Basin, Bering Sea, Alaska: An Overview.* Seattle, WA: National Oceanic and Atmospheric Administration, Northwest and Alaska Fisheries Center, National Marine Mammal Laboratory.
Braham, H. W. (1992). Scientific investigations of the National Marine Mammal Laboratory, 1990. *Polar Record, 28*(164), 43-46.
Braham, H. W., Burns, J. J., Fedoseev, G. A., & Krogman, B. D. (1981). *Distribution and density of ice-associated pinnipeds in the Bering Sea*. National Marine Mammal Laboratory (NMML).
Braham, H. W., Burns, J. J., Feoseev, G. A., Krogman, B. D., & Gennadii, A. (1984). *Habitat partitioning by ice-associated pinnipeds: Distribution and density of seals and walruses in the Bering Sea, April 1976*. National Oceanic and Atmospheric Administration (NOAA). pp. 25-48.
Braham, H. W., Fraker, M. A., & Krogman, B. D. (1980). Spring Migration of the Western Arctic Population of Bowhead Whales. *Marine Fisheries Review, 42*(9), 36-46.
Braham, H. W., & Rice, D. W. (1984). The right whale, Balaena glacialis. *Marine Fisheries Review, 46*(4), 38-44.
Branch, T. A. (2006). *Abundance estimates for Antarctic minke whales from three completed circumpolar sets of surveys, 1978 ⁄ 79 to 2003 ⁄ 2004*. Paper presented to IWC Scientific Commitee
Branch, T. A., Stafford, K., Palacios, D., Allison, C., Bannister, J., Burton, C., . . . Gill, P. (2007). Past and present distribution, densities and movements of blue whales Balaenoptera musculus in the Southern Hemisphere and northern Indian Ocean. *Mammal Review, 37*(2), 116-175.
Brandon, J. R., & Wade, P. R. (2006). Assessment of the Bering-Chukchi-Beaufort Seas stock of bowhead whales using Bayesian model averaging. *Journal of cetacean research and management, 8*(3), 225.
Brewer, S., Watson, J., Christensen, D., & Brocksmith, R. (2005). *Hood Canal & Eastern Strait of Juan de Fuca Summer Chum Salmon Recovery Plan*. Hood Canal Coordinating Council.
Brownell Jr., R. L., Clapham, P. J., Miyashita, T., & Kasuya, T. (2001). Conservation status of North Pacific right whales. *Journal of Cetacean Research and Management, Special Issue 2*, 269-286.
Brueggeman, J. J., Green, G. A., Grotefendt, R. A., Smultea, M. A., Volsen, D. P., Rowlett, R. A., . . . Burns, J. J. (1992). Marine Mammal Monitoring Porgram (Seals and Whales)

Crackerjack and Diamond Prospects Chukchi Sea. *Rep. from EBASCO Environmental, Bellevue, WA, for Shell Western E&P Inc. and Chevron USA Inc, 62*.

Brusca, R. C., & Brusca, G. J. (2003). Phylum Cnidaria. In *Invertebrates* (pp. 219-283). Sunderland: Sinauer Associates, Inc.

BST Associates. (2006). *Market Analysis for the Port of Port Angeles Marine Facilities Master Plan. FINAL REPORT.* Bothell, WA.

Buckstaff, K. C. (2004). Effects of watercraft noise on the acoustic behavior of bottlenose dolphins, Tursiops truncatus, in Sarasota Bay, Florida. *Marine Mammal Science, 20*(4), 709-725.

Budelmann, B. U. (1992a). Hearing by crustacea. In *Evolutionary Biology of Hearing* (pp. 131-139). New York: Springer-Verlag.

Budelmann, B. U. (1992b). Hearing in nonarthropod invertebrates. In *Evolutionary Biology of Hearing* (pp. 141-155). New York: Springer-Verlag.

Budelmann, B. U. (2010). *Cephalopoda*. Oxford, UK: Wiley-Blackwell.

Budge, S., Springer, A., Iverson, S. J., Sheffield, G., & Rosa, C. (2008). Blubber fatty acid composition of bowhead whales, Balaena mysticetus: Implications for diet assessment and ecosystem monitoring. *Journal of Experimental Marine Biology and Ecology, 359*(1), 40-46.

Burdin, A. M., Sychenko, O. A., & Sidorenko, M. M. (2013). *Status of western gray whales off northeastern Sakhalin Island, Russia in 2012*. Paper SC/65a/BRG3 presented to the International Whaling Commission Scientific Committee. [Available from http://www.iwcoffice.org/].

Bureau of Ocean Energy Management (BOEM). (2016). *Outer Continental Shelf Oil and Gas Leasing Program: 2017-2022*. OCS EIS/EA BOEM 2016-060. Published by the U.S. Department of the Interior, Bureau of Ocean Energy Management. 360 pp.

Burger, A. E. (2002). *Conservation assessment of marbled murrelets in British Columbia, a review of biology, populations, habitat associations and conservation*. (Technical Report Series No. 387). British Columbia: Canadian Wildlife Service, Environmental Conservation Branch. p. 168.

Burger, A. E. (2003). Effects of the Juan de Fuca Eddy and upwelling on densities and distributions of seabirds off southwest Vancouver Island, British Columbia. *Marine Ornithology, 31*, 113-122.

Burgess, W. C., & Greene Jr., C. R. (1999). *Physical Acoustic Measurements*. Houston, TX; Anchorage, AK; Silver Spring, MD. p. 390 pp.

Burgner, R. L. (1991). Life History of Sockeye Salmon (*Oncorhynchus nerka*). In. Groot, C. & Margolis, L. (Eds.), *Pacific Salmon Life Histories* (pp. 1-117). Vancouver, British Columbia: UBC Press.

Burgner, R. L., Harris, C. K., & Light, J. T. (1989). *Ocean Distribution and Migration of Steelhead (Oncorhynchus mykiss, formerly Salmo gairdneri)*. Seattle, WA: Fishries Research Institute. p. 50.

Burgner, R. L., Light, J. Y., Margolis, L., Okazaki, T., Tautz, A., & Ito, S. (1992). Distribution and Origins of Steelhead Trout (*Oncorhynchus mykiss*) in Offshore Waters of the North Pacific Ocean. *International North Pacific Fisheries Commission Bulletin, 51*.

Burkanov, V. N., & Loughlin, T. R. (2005). Distribution and abundance of Steller sea lions, Eumetopias jubatus, on the Asian coast, 1720's-2005. *Marine Fisheries Review, 67*(2), 1-62.

Burns, J. J. (1967). *The pacific bearded seal*. Juneau, AK: State of Alaska, Department of Fish and Game. p. 66.

Burns, J. J. (1970). Remarks on the distribution and natural history of pagophilic pinnipeds in the Bering and Chukchi Seas. *Journal of Mammalogy, 51*(3), 445-454.

Burns, J. J. (1981). *Bearded seal, Erignathus barbatus (Erxleben, 1777)* (Vol. 2: Seals). New York: Academic Press.

Burns, J. J., & Frost, K. J. (1979). *The natural history and ecology of the bearded seal, Erignathus barbatus*. Fairbanks, AK: Alaska Department of Fish and Game for the Outer Continental Shelf Environmental Assessment Program. p. 392.

Burns, J. J., Kelly, B. P., Aumiller, L. C., Frost, K. J., & Hills, S. (1982). *Studies of ringed seals in the Alaskan Beaufort Sea during winter: impacts of seismic exploration*.

Burns, J. J., Montague, J. J., & Cowles, C. J. (1993). *The bowhead whale*: Allen Pr.

Burns, J. M., & Kooyman, G. L. (2001). Habitat Use by Weddell Seals and Emperor Penguins Foraging in the Ross Sea, Antarctica. *American Zoologist, 41*(1), 90-98.

Bursk, M. K. (1983). *Effects of boats on migrating gray whales.* San Diego State University, San Diego, CA.

Bustnes, J. O., Asheim, M., Bjorn, T. H., Gabrielsen, H., & Systad, G. H. (2000). The diet of Steller's eiders winter in Varangerfjord, Northern Norway. *Wilson Bulletin, 112*, 8-13.

CAFF. (2013). *Arctic Biodiversity Assessment: Status and trends in Arctic biodiversity.* Akureyri, Iceland: Conservation of Arctic Flora and Fauna.

Cairns, D. K., Gaston, A. J., & Huettmann, F. (2008). Endothermy, ectothermy and the global structure of marine vertebrate communities. *Marine Ecology Progress Series, 356*, 239-250.

Calambokidis, J., & Barlow, J. (2004). Abundance of blue and humpback whales in the eastern North Pacific estimated by capture-recapture and line-transect methods. *20*(1), 63-85.

Calambokidis, J., Falcone, E., Douglas, A. B., Schlender, L., & Huggins, J. (2009a). *Photographic identification of humpback and blue whales off the U.S. West Coast: results and updated abundance estimates from 2008 field season*. (Final Report for Contract AB133F08SE2786).

Calambokidis, J., Falcone, E. A., Quinn, T. J., Burdin, A. M., Clapham, P., Ford, J., . . . Rojas-Bracho, L. (2008). SPLASH: Structure of populations, levels of abundance and status of humpback whales in the North Pacific. *Unpublished report submitted by Cascadia Research Collective to USDOC, Seattle, WA under contract AB133F-03-RP-0078 [available from the author]*.

Calambokidis, J., Laake, J. L., & Klimek, A. (2012). *Updated analysis of abundance and population structure of seasonal gray whales in the Pacific Northwest 1998-2010*. p. 65 p.

Calambokidis, J., Steiger, G. H., Curtice, C., Harrison, J., Ferguson, M. C., Becker, E., . . . Parijs, S. M. V. (2015). 4. Biologically Important Areas for selected cetaceans within U.S. waters – West Coast region. *41*(1), 39-53.

Calambokidis, J., Steiger, G. H., Straley, J. M., Herman, L. M., Cerchio, S., Salden, D. R., . . . Quinn, T. J., II. (2001). Movements and population structure of humpback whales in the North Pacific. *Marine Mammal Science, 17*(4), 769-794.

Calambokidis, J. J., Barlow, J., Ford, J. K. B., Chandler, T. E., & Douglas, A. B. (2009b). Insights into the population structure of blue whales in the Eastern North Pacific from recent sightings and photographic identification. *Marine Mammal Science, 25*, 816-832.

Caldwell, D. K., & Caldwell, M. C. (1989). Pygmy sperm whale Kogia breviceps (de Blainville 1838); dwarf sperm whale Kogia simus (Owen 1866). In. Ridgway, S. H. & Harrison, R. (Eds.), *Handbook of marine mammals* (Vol. Vol. 4: River dolphins and the larger toothed whales, pp. 235-260). San Diego, CA: Academic Press.

California Department of Fish and Wildlife. (2016). Coho Salmon Life History Retrieved from http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoLifeHistory.asp as accessed on 4/20/16.

Calvert, W., & Stirling, I. (1985). Winter distribution of ringed seals (Phoca hispida) in the Barrow Strait area, Northwest Territories, determined by underwater vocalizations. *Canadian Journal of Fisheries and Aquatic Sciences, 42*(7), 1238-1243.

Cameron, M., & Boveng, P. (2007). Abundance and distribution surveys for ice seals aboard USCG Healy and the Oscar Dyson, April 10-June 18, 2007. *Apr-June 2007*.

Cameron, M., & Boveng, P. (2009). *Habitat use and seasonal movements of adult and subadult bearded seals*. Alaska Fisheries Science Center. p. 4.

Carretta, J. V., & Forney, K. A. (1993). *Report of the two aerial surveys for marine mammals in California coastal waters utilizing a NOAA DeHavilland Twin Otter aircraft, March 9-April 7, 1991 and February 8-April 6, 1992*: US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Carretta, J. V., Forney, K. A., Oleson, E., Weller, D. W., Lang, A. R., Baker, J., . . . Huber, H. (2017). *U.S. Pacific Marine Mammal Stock Assessments: 2016*. La Jolla, CA: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center. p. 414.

Castellote, M., Clark, C. W., & Lammers, M. O. (2011). Acoustic and behavioural changes by fin whales (Balaenoptera physalus) in response to shipping and airgun noise. *Biological Conservation, 147*(2012), 115-122. doi: 10.1016/j.biocon.2011.12.021.

Castro, P., & Huber, M. E. (2000). *Marine animals without a backbone*: McGraw-Hill.

Cawthorn, M. W. (1992). *New Zealand. Progress report on cetacean research, April 1990 to April 1991*. Report to the International Whaling Commission. pp. 357-360.

CBRE Research. (2015). North America Port and Logistics Annual Report. Annual report prepared by the CBRE's Port Logistics group. Retrieved from http://www.cbre.us/UnitedStates/Real-Estate-Services/Industry-Solutions/Industrial-and-Logistics/Port-and-Integrated-Logistics as accessed on 16 May 2017.

CDFG. (2002). *Status Review of California Coho Salmon north of San Francisco*. Monterey, CA: California Department of Fish and Game.

Celi, M., Filiciotto, F., Vazzana, M., Arizza, V., Maccarrone, V., Ceraulo, M., . . . Buscaino, G. (2014). Shipping noise affecting immune responses of European spiny lobster (Palinurus elephas). *Canadian Journal of Zoology, 93*(2), 113-121.

Central Intelligence Agency. (2017). Antarctica: People and Society. *The World Factbook* Retrieved from https://www.cia.gov/library/publications/the-world-factbook/geos/ay.html

Cerchio, S., Jacobsen, J. K., & Norris, T. F. (2001). Temporal and geographical variation in songs of humpback whales, Megaptera novaeangliae: synchronous change in Hawaiian and Mexican breeding assemblages. *Animal Behaviour, 62*(2), 313-329.

Chapman, N. R., & Price, A. (2011). Low frequency deep ocean ambient noise trend in the Northeast Pacific Ocean. *Journal of the Acoustical Society of America, 129*, EL161−EL165.

Chappell, M. A., Shoemaker, V. H., Janes, D. N., Bucher, T. L., & Maloney, S. K. (1993). Diving Behavior During Foraging in Breeding Adelie Penguins. *Ecology, 74*(4), 1204-1215. doi: 10.2307/1940491.

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.

Chittleborough, R. (1965). Dynamics of two populations of the humpback whale, Megaptera novaeangliae (Borowski). *Marine and Freshwater Research, 16*(1), 33-128.

Christiansen, F., Dujon, A. M., Sprogis, K. R., Arnould, J. P., & Bejder, L. (2016). Noninvasive unmanned aerial vehicle provides estimates of the energetic cost of reproduction in humpback whales. *Ecosphere, 7*(10).

Citta, J. J., Quakenbush, L. T., Okkonen, S. R., Druckenmiller, M. L., Maslowski, W., Clement-Kinney, J., . . . Ashjian, C. J. (2015). Ecological characteristics of core-use areas used by Bering–Chukchi–Beaufort (BCB) bowhead whales, 2006–2012. *Progress in Oceanography, 136*, 201-222.

City of Nome Alaska. (2016). Nome: An Arctic Port for the Nation. In City of Nome, A. (Ed.). Nome, Alaska. Retrieved

Clapham, P., Shelden, K., & Wade, P. (2006). *Habitat Requirements and Extinction Risks of Eastern Northern Pacific Right Whales*.

Clapham, P. J., Good, C., Quinn, S. E., Reeves, R. R., Scarff, J. E., & Brownell, R. L. (2004). Distribution of North Pacific right whales (Eubalaena japonica) as shown by 19th and 20th century whaling catch and sighting records. *Journal of Cetacean Research and Management, 6*(1), 1-6.

Clapham, P. J., Leatherwood, S., Szczepaniak, I., & Brownell, R. L. (1997). Catches of humpback and other whales from shore stations at Moss Landing and Trinidad, California, 1919–1926. *Marine Mammal Science, 13*(3), 368-394.

Clapham, P. J., & Mattila, D. K. (1990). Humpback whale songs as indicators of migration routes. *Marine Mammal Science, 6*(2), 155-160.

Clapham, P. J., & Mead, J. G. (1999). Megaptera novaeangliae. *Mammalian Species*(604), 1-9.

Clark, C. W., Ellison, W. T., Southall, B. L., Hatch, L. T., Parijs, S. M. V., Frankel, A. S., & Ponirakis, D. (2009). Acoustic masking in marine ecosystems: intuitions, analysis, and implication. *Marine Ecology Progress Series, 395*, 201-222.

Clarke, A. (1996). Benthic Marine Habitats in Antarctica. *Foundations for Ecological Research West of the Antarctic Peninsula, Antarctic Research Series, 70*, 123-133. doi: 10.1029/AR070p0370.

Clarke, A. (2008). Antarctic marine benthic diversity: patterns and processes. *Journal of Experimental Marine Biology and Ecology, 366*(1), 48-55.
Clarke, A., & Johnston, N. M. (2003). Antarctic marine benthic diversity. *Oceanography and marine biology, 41*, 47-114.
Clarke, J., & Ferguson, M. (2010). Aerial surveys for bowhead whales in the Alaskan Beaufort Sea: BWASP Update 2000-2009 with comparisons to historical data. *Unpublished paper to the IWC Scientific Committee, Agadir, Morocco*.
Clarke, J., Stafford, K., Moore, S. E., Rone, B., Aerts, L., & Crance, J. (2013a). Subarctic cetaceans in the southern Chukchi Sea: evidence of recovery or response to a changing ecosystem. *Oceanography, 26*(4), 136-149.
Clarke, J. T., Brower, A. A., Christman, C. L., & Ferguson, M. C. (2014). Distribution and relative abundance of marine mammals in the northeastern Chukchi and western Beaufort seas, 2013. *Annual Report, OCS Study BOEM 2014-018. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115-6349*.
Clarke, J. T., Christman, C. L., Brower, A. A., & Ferguson, M. C. (2013b). Distribution and relative abundance of marine mammals in the northeastern Chukchi and western Beaufort seas, 2012. *Annual Report, OCS Study BOEM 2013-00117. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115-6349*.
Clarke, J. T., Ferguson, M. C., Curtice, C., & Harrison, J. (2015). 8. Biologically Important Areas for Cetaceans Within US Waters-Arctic Region. *Aquatic Mammals, 41*(1), 94.
Clarke, J. T., Moore, S. E., & Ljungblad, D. K. (1989). Observations on gray whale (Eschrichtius robustus) utilization patterns in the northeastern Chukchi Sea, July-October 1982-1987. *Canadian Journal of Zoology, 67*(11), 2646-2654.
Clarke, R. (1956). Marking whales from a helicopter. *Norsk Hvalfangst-Tid, 45*(6), 311-318.
Clarke, R. (2004). Pygmy fin whales. *Marine mammal science, 20*(2), 329-334.
Cleary, E. C., Dolbeer, R. A., & Wright, S. E. (2006). Wildlife strikes to civil aircraft in the United States 1990-2005.
Coast Guard News. (2017). Coast Guard Cutter Polar Star arrives at McMurdo Station, Antarctica Retrieved from http://coastguardnews.com/coast-guard-cutter-polar-star-arrives-at-mcmurdo-station-antarctica/2017/01/18/ as accessed on 15 May 2017.
Cohen, D. M., Iwamoto, I. T., & Scialabba, N. (1990). *Vol 10. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers, and other gadiform fishes known to date.* Rome, Italy. p. 442
Cohen, S. (2014). *The Impacts of the Maritime Industry in Washington State. Maritime and Manufacturing Task Force Meeting, September 30, 2014.* Seattle, WA: Community Attributes Inc.
Commission for the Conservation of Antarctic Marine Living Resources. (2016a). *Fishery Report 2016: Exploratory fishery for Dissostichus spp. in Subarea 88.1*. Commission for the Conservation of Antarctic Marine Living Resources. p. 33.
Commission for the Conservation of Antarctic Marine Living Resources. (2016b). *Fishery Report 2016: Exploratory fishery for Dissostichus spp. in Subarea 88.2*. Commission for the Conservation of Antarctic Marine Living Resources. p. 17.

Commission for the Convention of Antarctic Marine Living Resources. (2017a). Antarctic Fisheries Retrieved from https://www.ccamlr.org/en/fisheries/fisheries as accessed on 01 March 2017.

Commission for the Convention of Antarctic Marine Living Resources. (2017b). Krill – biology, ecology and fishing Retrieved from https://www.ccamlr.org/en/fisheries/krill-fisheries as accessed on 01 March 2017.

Commission for the Convention of Antarctic Marine Living Resources. (2017c). Toothfish Fisheries Retrieved from https://www.ccamlr.org/en/fisheries/toothfish-fisheries as accessed on 01 March 2017.

Commission, I. I. W. (2010). Report of the workshop on cetaceans and climate change. *J Cetacean Res Manag Suppl, 11*(2), 451-480.

Community Attributes Inc. (2013). *Washington State Maritime Cluster Economic Impact Study*. Seattle, Washington: Prepared for the Economic Development Council of Seattle and King County.

Conn, P. B., Ver Hoef, J. M., McClintock, B. T., Moreland, E. E., London, J. M., Cameron, M. F., . . . Boveng, P. L. (2014). Estimating multispecies abundance using automated detection systems: ice-associated seals in the Bering Sea. *Methods in Ecology and Evolution, 5*(12), 1280-1293.

Constantine, R., Brunton, D. H., & Baker, C. S. (2003). *Effects of tourism on behavioural ecology of bottlenose dolphins of northeastern New Zealand*. Department of Conservation Wellington, New Zealand.

Constantine, R., Brunton, D. H., & Dennis, T. (2004). Dolphin-Watching Tour Boats Change Bottlenose Dolphin (*Tursiops truncatus*) Behaviour. *Biological Conservation, 117*, 299-307.

Cook, A. S. C. P., Johnston, A., Wright, L. J., & Burton, N. H. K. (2012). *A review of flight heights and avoidance rates of birds in relation to offshore wind farms*. Norfolk, UK: The British Trust for Ornithology.

Cooke, J. G., Weller, D. W., Bradford, A. L., Sychenko, O., Burdin, A. M., & Brownell Jr, R. L. (2013). Population assessment of the Sakhalin gray whale aggregation. *SC/65a/BRG27. IWC Scientific Committee*.

Cooney, R. T. (Ed.). (1981). *Bering Sea zooplankton and micronecton communities with emphasis on annual production* (Vol. 2). Juneau, Alaska: NOAA.

Cosens, S. E., Cleator, H., & Richard, P. (2006). *Numbers of bowhead whales (Balaena mysticetus) in the Eastern Canadian Arctic: Based on aerial surveys in August 2002, 2003 and 2004*: Fisheries and Oceans Canada, Science.

COSEWIC. (2004). *COSEWIC assessment and update status report on the narwhal Monodon monoceros in Canada*. Ottowa, Canada: Committee on the Status of Endangered Wildlife in Canada. p. 50 p.

Costa, D. P., Crocker, D. E., Waples, D. M., Webb, P. M., Gedamke, J., Houser, D., . . . Calambokidis, J. (1998). *The California Marine Mammal Research Program of the Acoustic Thermometry of Ocean Climate experiment: Potential effects of low frequency sound on distrubition and behavior of marine mammals.* Paper presented at the California and the World Ocean '97: Taking a look at California's Ocean Resources: An Agenda for the Future.

Council on Environmental Quality. (1997). *Considering Cumulative Effects under the National Environmental Policy Act*. Washington, DC: Council on Environmental Quality Executive Office of the President. p. 122.

Council on Environmental Quality. (2005). *Guidance on the Consideration of Past Actions in Cumulative Effects Analysis*. Washington, DC: Council on Environmental Quality.

Coyle, K. (2000). Zooplankton densities in the right whale feeding areas of Cape Newenham, southeastern Bering Sea: report on the results of analysis of seven MOCHNESS tows taken in the whale foraging areas. 13. *Final Report to NMFS/NMML*.

Cranford, T. W., & Krysl, P. (2015). Fin whale sound reception mechanisms: skull vibration enables low-frequency hearing. *PloS one, 10*(1), e0116222.

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

Croll, D. A., Gaston, A. J., Burger, A. E., & Konnoff, D. (1992). Foraging Behavior and Physiological Adaptation for Diving in Thick-Billed Murres. *Ecology, 73*(1), 344-356. doi: 10.2307/1938746.

Crowell, S. E., Wells-Berlin, A. M., Carr, C. E., Olsen, G. H., Therrien, R. E., Yannuzzi, S. E., & Ketten, D. R. (2015). A comparison of auditory brainstem responses across diving bird species. *Journal of Comparative Physiology A, 201*, 803-815.

Cunningham, K. A., & Reichmuth, C. (2016). High-frequency hearing in seals and sea lions. *Hearing Research, 331*, 83-91.

Dahlheim, M., Leatherwood, S., & Perrin, W. F. (1982). Distribution of killer whales in the warm temperate and tropical eastern Pacific. *Report of the International Whaling Commission, 32*, 647-653.

Dahlheim, M. E. (1994). Assessment of injuries and recovery monitoring of Prince William Sound killer whales using photo-identification techniques. *Seattle (WA): National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Restoration Project 93042l94092 Final Report*.

Dahlheim, M. E. (1997). *A photographic catalog of killer whales, Orcinus orca, from the central Gulf of Alaska to the southeastern Bering Sea* (Vol. 131): Seascape Research Alliance.

Dahlheim, M. E., & Heyning, J. E. (1999). Killer whale Orcinus orca (Linnaeus, 1758). *Handbook of marine mammals, 6*, 281-322.

Dahlheim, M. E., & Ljungblad, D. K. (1990). Preliminary hearing study on gray whales (Eschrichtius robustus) in the field. In *Sensory abilities of cetaceans* (pp. 335-346): Springer.

Darling, J. D. (1984). Gray whales off Vancouver Island, British Columbia. In. Jones, M. L., Swartz, S. L. & Leatherwood, S. (Eds.), *The Gray Whale, Eschrichtius robustus* (pp. 267-287). Orlando, Florida: Academic Press.

Dau, C. P. (1976). Clutch sizes of the spectacled eider on the Yukon-Kushokwim Delta, Alaska. *Wildfowl, 27*, 111-113.

Dau, C. P., & Kistchinski, A. A. (1977). Seasonal movements and distribution of the spectacled eider. *Wildfowl, 28*, 65-75.

Dawbin, W. H. (1966). The seasonal migratory cycle of humpback whales. *Whales, dolphins and porpoises. University of California Press, Berkeley*, 145-170.

Dawes, C. J. (1998). *Marine Botany* (Second Edition ed.). New York, NY: John Wiley and Sons, Inc.
Day, R. H., & Nigro, D. A. (2000). Feeding ecology of Kittlitz's and marbled murrelets in Prince William Sound, Alaska. *Waterbirds, 23*(1), 1-14.
Day, R. H., Prichard, A. K., & Rose, J. R. (2005). *Migration and collision avoidance of eiders and other birds at Northstar Island, Alaska, 2001-2004: Final report*. Anchorage, Alaska: BP Exploration (Alaska) Inc. p. 154.
Dean, J. (1998). Animats and what they can tell us. *Trends in Cognitive Sciences, 2*(2), 60-67.
DeMaster, D. (2014). *Results of Steller sea lion surveys in Alaska, June-July 2013*. Juneau, AK.
Department of Defense. (2013). Arctic Strategy. Retrieved from https://www.defense.gov/Portals/1/Documents/pubs/2013_Arctic_Strategy.pdf as accessed on 16 May 2017.
Department of Interior. (2015). *Offshore Lease Sales, Beaufort and Chukchi Sea Lease Sales will be Cancelled in Current Five Year Oil and Gas Program.* Press release: Department of the Interior. October 16, 2015.
DeRuiter, S. L., Tyack, P. L., Lin, Y.-T., Newhall, A. E., Lynch, J. F., & Miller, P. J. O. (2006). Modeling acoustic propagation of airgun array pulses recorded on tagged sperm whales (Physeter macrocephalus). *Journal of the Acoustical Society of America, 120*, 4100-4114.
Descamps, S., Aars, J., Fuglei, E., Kovacs, K. M., Lydersen, C., Pavlova, O., . . . Strøm, H. (2017). Climate change impacts on wildlife in a High Arctic archipelago – Svalbard, Norway. *Global Change Biology, 23*(2), 490-502. doi: 10.1111/gcb.13381.
Desimone, S. M. (2016). *Periodic status review for the Marbled Murrelet in Washington*. Olympia, Washington: Washington Department of Fish and Wildlife.
DFW, W. (2011). *Puget Sound Rockfish Conservation Plan*. Olympia, Washington 98501: Washington Department of Fish and Wildlife. p. 34.
Di Iorio, L., & Clark, C. W. (2010). Exposure to seismic survey alters blue whale acoustic communication. *Biology Letters, 6*(1), 51-54. doi: 10.1098/rsbl.2009.0651.
Divoky, G. J. (1976). The pelagic feeding habits of Ivory and Ross' Gulls. *Condor.*(78), 85-90.
Doi, Y., Kanesawa, Y., Tanahashi, N., & Kumagai, Y. (1992). Biodegradation of microbial polyesters in the marine environment. *Polymer degradation and stability, 36*(2), 173-177.
Donovan, G. (1991). A review of IWC stock boundaries. *Rep. Int. Whal. Comm.(Special Issue), 13*, 39-68.
Dooling, R. J. (2002). *Avian hearing and avoidance of wind turbines*. (NREL/TP-500-30844). Golden, CO: National Renewable Energy Laboratory. p. 84.
Dooling, R. J., & Popper, A. N. (2007). The effects of highway noise on birds. *Sacramento, CA: The California Department of Transportation Division of Environmental Analysis, 74*.
Dooling, R. J., Ryals, B. M., Dent, M. L., & Reid, T. L. (2006). Perception of complex sounds in budgerigars (Melopsittacus undulatus) with temporary hearing loss. *The Journal of the Acoustical Society of America, 119*(4), 2524-2532.
Dooling, R. J., & Therrien, S. C. (2012). Hearing in birds: What changes from air to water. In *The Effects of Noise on Aquatic Life* (pp. 77-82): Springer.

Dorsey, E. M., Stern, S. J., Hoelzel, A. R., & Jacobsen, J. (1990). Minke whale (Balaenoptera acutorostrata) from the west coast of North America: individual recognition and small-scale site fidelity. *Rep. Int. Whal. Comm.(Special Issue), 12*, 357-368.

Drake, J. S., E.A. Berntson, J.M. Cope, R.G. Gustafson, E.E.Holmes, P.S. Levin, . . . Williams, G. D. (2010). *Status review of five rockfish species in Puget Sound, Washington: bocaccio (Sebastes paucispinis), canary rockfish (S. pinniger), yelloweye rockfish (S. ruberrimus), greenstriped rockfish (S. elongatus), and redstripe rockfish (S. proriger).* p. 234.

Drout, V. (2003). *Ecology of sperm whales (Physeter macrocephalus) in the Mediterranean Sea.* PhD Thesis, University of Wales, Bangor.

Dueck, L. P., Heide-Jørgensen, M., Jensen, M. V., & Postma, L. D. (2006). *Update on investigations of bowhead whale (Balaena mysticetus) movements in the eastern Arctic, 2003-2005, based on satellite-linked telemetry*: Fisheries and Oceans.

Duffy, E. J., Beauchamp, D. A., & Buckley, R. M. (2005). Early Marine Life History of Juvenile Pacific Salmon in two Regions of Puget Sound. *Estuarine, Coastal and Shelf Science, 64*, 94-107.

Dunton, K. H., Goodall, J. L., Schonberg, S. V., Grebmeier, J. M., & Maidment, D. R. (2005). Multi-decadal syntehsis of benthic-pelagic coupling in the western arctic: Role of cross-shelf advective processes. *Deep Sea Res., Part II, 52*, 3462-3477.

Durban, J., Weller, D., Lang, A., & Perryman, W. (2013). *Estimating gray whale abundance from shore-based counts using a multilevel Bayesian model*. presented to the International Whaling Commission.

Durner, G. M., Amstrup, S. C., & Ambrosius, K. J. (2001). Remote identification of polar bear maternal den habitat in northern Alaska. *Arctic, 54*(2), 115-121.

Durner, G. M., Amstrup, S. C., Neilson, R., & McDonald, T. (2004). *The use of sea ice habitat by female polar bears in the Beaufort Sea*. (OCS Study MMS 2004-014). Anchorage, AK: U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region. p. 41.

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

Dutton, P. H., Balazs, G., Dizon, A., & Barragan, A. (2000). *Genetic stock identification and distribution of leatherbacks in the Pacific: potential effects on declining populations.* Paper presented at the Proceedings of the Eighteenth International Sea Turtle Symposium.

Dziak, R. P., Bohnenstiehl, D. R., Stafford, K. M., Matsumoto, H., Park, M., & Lee, W. S. (2015). Sources and Levels of Ambient Ocean Sound near the Antarctic Peninsula. *PLoS ONE 10*(4).

Eamer, J., Donaldson, G. M., Gaston, A. J., Kosobokova, K. N., Lárusson, K. F., Melnikov, I. A., . . . von Quillfeldt, C. H. (2013) Life Linked to Ice: A guide to sea-ice-associated biodiversity in this time of rapid change. CAFF Assessment Series No. 10. Conservation of Arctic Flora and Fauna, Iceland.

Eckert, S. A. (1999). *Habitats and migratory pathways of the Pacific leatherback sea turtle*. (12336). National Marine Fisheries Service (NMFS).
Edmonds, N. J., Firmin, C. J., Goldsmith, D., Faulkner, R. C., & Wood, D. T. (2016). A review of crustacean sensitivity to high amplitude underwater noise: Data needs for effective risk assessment in relation to UK commercial species. *Marine pollution bulletin, 108*(1), 5-11.
Efroymson, R. A., Suter, I. I., Glenn, W., Rose, W. H., & Nameth, S. (2001). Ecological Risk Assessment Framework for Low-Altitude Aircraft Overflights: I. Planning the Analysis and Estimating Exposure. *Risk Analysis, 21*(2), 251-262.
Eisner, L. B., Napp, J. M., Mier, K. L., Pinchuk, A. I., & Andrews, A. G. (2014). Climate-mediated changes in zooplankton community structure for the eastern Bering Sea. *Deep Sea Research Part II: Topical Studies in Oceanography, 109*, 157-171.
Eller, A. I., & Cavanagh, R. C. (2000). *Subsonic Aircraft Noise at and Beneath the Ocean Surface: Estimation of Risk for Effects on Marine Mammals*. DTIC Document.
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.
Emmett, R. L., Hinton, S. A., Stone, S. L., & Monaco, M. E. (1991). *Distribution and Abundance of the Fishes and Invertebrates in West Coast Estuaries. Volume II: Species Life History Summaries. ELMR Report No. 8*. Rockville, Maryland: NOAA/NOS Strategic Environmental Assessments Division. p. 329.
Engelhaupt, D. T. (2004). *Phylogeographyj kinship and molecular ecology of sperm whales (Physeter macrocephalus).* Durham University.
Enticott, J., & Tipling, D. (1997). *Seabirds of the World: The Complete Reference*. Mechanicsburg, PA: Stackpole Books.
Erbe, C., Reichmuth, C., Cunningham, K., Lucke, K., & Dooling, R. (2016). Communication masking in marine mammals: A review and research strategy. *Marine pollution bulletin, 103*(1), 15-38.
Etnoyer, P., & Morgan, L. E. (2005). *Habitat-forming deep-sea corals in the Northeast Pacific Ocean*: Springer-Verlag.
Evans, T. J., Fischbach, A., Schliebe, S., Manly, B., Kalxdorff, S., & York, G. (2003). Polar bear aerial survey in the eastern Chukchi Sea: a pilot study. *Arctic*, 359-366.
Fall, J. (2016). *Subsistence in Alaska: A Year in 2014 Update*. Anchorage, Alaska: Alaska Department of Fish and Game. p. 4 p.
Farley, E. V., Murphy, J. M., Adkison, M., & Eisner, L. (2007). Juvenile sockeye salmon distribution, size, condition and diet during years with warm and cool spring sea temperatures along the eastern Bering Sea shelf. *Journal of Fish Biology, 71*(4), 1145-1158. doi: 10.1111/j.1095-8649.2007.01587.x.
Fay, F. H. (1974). *The role of ice in the ecology of marine mammals of the Bering Sea*: University of Alaska, Institute of Marine Science.
Fay, F. H., Kelly, B. P., Gehnrich, P. H., Sease, J. L., & Hoover, A. A. (1984). *Modern populations, migrations, demography, trophics, and historical status of the Pacific walrus*. Outer Continental Shelf Environmental Assessment Program.

Federal Subsistence Management Program. (2017). *Subsistence Management Regulations for the Harvest of Fish and Shellfish on Federal Public Lands and Waters in Alaska, Effective April 1, 2017–March 31, 2019*. Office of Subsistence Management.

Fedoseev, G. A. (1965). *The ecology of the reproduction of seals on the northern part of the Sea of Okhotsk*. (Fisheries and Marine Service Translation Series No. 3369). USSR: Department of the Environment, Fisheries and Marine Service, Arctic Biological Station. pp. 212-216.

Félix, F., & Haase, B. (2001). The humpback whale off the coast of Ecuador, population parameters and behavior. *Revista de Biología Marina y Oceanografía, 36*(1), 61-74.

Ferguson, M. C., Waite, J. M., Curtice, C., Clarke, J. T., & Harrison, J. (2015). 7. Biologically Important Areas for Cetaceans Within US Waters-Aleutian Islands and Bering Sea Region. *Aquatic Mammals, 41*(1), 79.

Ferrero, R. C., & Walker, W. A. (1996). Age, growth and reproductive patterns of the Pacific white-sided dolphin (Lagenorhynchus obliquidens) taken in high seas driftnets in the central North Pacific Ocean. *Canadian Journal of Zoology, 74*(9), 1673-1687.

Fewtrell, J. L., & McCauley, R. D. (2012). Impact of air gun noise on the behaviour of marine fish and squid. *Marine Pollution Bulletin, 64*, 984-993.

Finley, K. J. (1982). The estuarine habitat of the beluga or white whale, Delphinapterus leucas. *Cetus, 4*, 4-5.

Finneran, J. (2016). Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise. *National Marine Fisheries Service. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. US Department of Commerce, NOAA. NOAA Technical Memorandum. NMFS-OPR-55*, 38-110.

Finneran, J. J., Carder, D. A., Schlundt, C. E., & Ridgway, S. H. (2005). Temporary Threshold Shift in Bottlenose Dolphins (*Tursiops truncatus*) Exposed to Mid-frequency Tones. *Journal of the Acoustic Society of America, 118*(4), 2696-2705.

Finneran, J. J., Dear, R., Carder, D. A., & Ridgway, S. H. (2003). Auditory and behavioral responses of California sea lions (Zalophus californianus) to single underwater impulses from an arc-gap transducer. *J Acoust Soc Am, 114*(3), 1667-77.

Finneran, J. J., Schlundt, C. E., Carder, D. A., Clark, J. A., Young, J. A., Gaspin, J. B., & Ridgway, S. H. (2000a). Auditory and behavioral responses of bottlenose dolphins (Tursiops truncatus) and a beluga whale (Delphinapterus leucas) to impulsive sounds resembling distant signatures of underwater explosions. *Journal of the Acoustical Society of America, 108*(1), 417-431.

Finneran, J. J., Schlundt, C. E., Dear, R., Carder, D. A., & Ridgway, S. H. (2000b). Masked temporary threshold shift—MTTS—in odontocetes after exposure to single underwater impulses from a seismic water gun. *Journal of Acoustic Society of America, 108*, 2515.

Fiscus, C. F. (1983, 28 March - 5 April, 1983). *Fur seals.* Paper presented at the Background papers submitted by the United States to the 26th annual meeting of the Standing Scientific Committee of the North Pacific Fur Seal Commission, Washington D.C.

Fiscus, C. H., Braham, H. W., Mercer, R. W., Everitt, R. D., Krogman, B. D., McGuire, P. D., . . . Withrow, D. E. (1976). *Seasonal distribution and relative abundance of marine mammals in the Gulf of Alaska*. National Marine Fisheries Service (NMFS). p. 246.

Fiscus, C. H., & Niggol, K. (1965). *Observations of cetaceans off California, Oregon, and Washington*: US Department of Interior, Fish and Wildlife Service.

Flannery, B. G., Spangler, R. E., Norcross, B. L., Lewis, C. J., & Wenburg, J. K. (2013). Microsatellite analysis of population structure in Alaska Eulachon with application to mixed-stock analysis. *Transactions of the American Fisheries Society, 142*(4), 1036-1048.

Flinn, R. D., Trites, A. W., & Gregr, E. J. (2002). Diets of fin, sei, and sperm whales in British Columbia: An analysis of commercial whaling records, 1963-1967. *Marine Mammal Science, 18*(2), 663-679.

Flórez –González, L., Capella, J., Haase, B., Bravo, G. A., Felix, F., & Gerrodette, T. (1998). Changes in Winter destinations and the most record of southeastern pacific humpback whales. *Marine Mammal Science, 14*(1), 189-196.

Foote, A. D., Osborne, R. W., & Hoelzel, A. R. (2004). Whale-call response to masking boat noise. *Nature, 428*, 910.

Ford, J. K. B., Ellis, G. M., & Balcomb, K. C. (2000). *Killer whales: the natural history and genealogy of Orcinus orca in British Columbia and Washington State* (2nd Edition ed.). Vancouver, British Columbia: UBC Press.

Forney, K. A. (1994). *Recent information on the status of odontocetes in Californian waters*. U.S. Department of Commerce. p. 87 p.

Forney, K. A. (2007). *Preliminary estimates of cetacean abundance along the US west coast and within four National Marine Sanctuaries during 2005*.

Forney, K. A., Barlow, J., & Carretta, J. V. (1995). The abundance of cetaceans in California waters. Part II: Aerial surveys in winter and spring of 1991 and 1992. *Fisheries Bulletin, 93*, 15-26.

Forney, K. A., & Wade, P. R. (2006). Worldwide distribution and abundance of killer whales. *Whales, whaling and ocean ecosystems*, 145-162.

Fredrickson, L. H. (2001). Steller's eider (*Polysticta stelleri*). In. Poole, A. & Gill, F. (Eds.), *The Birds of North America*. Philadelphia, PA: The Birds of North America Inc.

Freedman, B., Stelle, W., Stiffarm, D., Angelis, T., & Brick, S. (2004). Indian Law Handbook For Local Governments. Prepared by Preston, Gates, and Ellis LLP. Retrieved from http://www.klgates.com/files/Publication/7eed9f21-ff2c-4a90-a551-4149663ce35b/Presentation/PublicationAttachment/42bfdb94-3f93-4c1c-9396-432a176ca8b2/ILHandbook05%5B1%5D.pdf as accessed on 12 May 2017.

Freitas, C., Kovacs, K. M., Ims, R. A., & Lydersen, C. (2008). Predicting habitat use by ringed seals (Phoca hispida) in a warming Arctic. *217*, 19-32.

Freiwald, A., Fosså, J. H., Grehan, A., Koslow, T., & Roberts, J. M. (2004). *Cold-water coral reefs: Out of sight - no longer out of mind*. Cambridge, UK: United Nations Environment Programme-World Conservation Monitoring Centre.

Friday, N. A., Zerbini, A. N., Waite, J. M., Moore, S. E., & Clapham, P. J. (2013). Cetacean distribution and abundance in relation to oceanographic domains on the eastern Bering Sea shelf, June and July of 2002, 2008, and 2010. *Deep Sea Research Part II: Topical Studies in Oceanography, 94*, 244-256.

Frisk, G. V. (2012). Noiseonomics: the relationship between ambient noise levels in the sea and global economic trends. *Sci Rep, 2*, 437.

Fritz, L. W., Sweeney, K., Johnson, D., Lynn, M., Gelatt, T., & Gilpatrick, J. (2013). *Aerial and ship-based surveys of Steller sea lions (Eumetopias jubatus) conducted in Alaska in June-July 2008 through 2012, and an update on the status and trend of the western Distinct Population Segment in Alaska*. U.S. Department of Commerce. p. 91 p.

Froese, R., & Pauly, D. (2013). FishBase. Retrieved from http://www.fishbase.org.

Frost, K. (1985). The ringed seal (Phoca hispida). *Marine Mammals Species Accounts. Alaska Department Fish and Game, Juneau, AK*, 79-87.

Frost, K. J., & Lowry, L. F. (1984). Trophic relationships of vertebrate consumers in the Alaskan Beaufort Sea. In *The Alaskan Beaufort Sea - Ecosystems and Environments* (pp. 381-401): Academic Press, Inc.

Furgal, C., Kovacs, K., & Innes, S. (1996). Characteristics of ringed seal, Phoca hispida, subnivean structures and breeding habitat and their effects on predation. *Canadian Journal of Zoology, 74*(5), 858-874.

Gambell, R. (1985). Fin Whale Balaenoptera physalus. In. Ridgway, S. H. & Harrison, R. (Eds.), *Handbook of Marine Mammals Vol. 3: The Sirenians and Baleen Whales* (Vol. 3, pp. 171-192).

Gambell, R., Bonner, W., & Walton, D. (1985). Birds and mammals–Antarctic whales. *Antarctica*, 223-241.

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

Garner, G. W., McDonald, L., Robson, D., Young Jr, D., & Arthur, S. (1992). Literature review: population estimation methodologies applicable to the estimation of abundance of polar bears. *Anchorage, AK: US Fish and Wildlife Service, Alaska Fish and Wildlife Research Center*.

Garner, G. W., Stishov, M. S., Wiig, O., Boltunov, A., Belchansky, G. I., Douglas, D. C., . . . Schliebe, S. (1998, 3-7 February, 1997). *Polar bear research in western Alaska, eastern and western Russia 1993-1996. .* Paper presented at the Proceedings of the Twelfth Working Meeting of the IUCN/SSC Polar Bear Specialist Group, Oslo, Norway.

Gaskin, D. E. (1964). *Recent observations in New Zealand waters on some aspects of behaviour of the sperm whale (Physeter macrocephalus)*: Fisheries Laboratory, Marine Department.

Gaskin, D. E. (1984). The harbor porpoise Phocoena phocoena (L.): Regional populations, status, and information on direct and indirect catches *Rep. Int. Whal. Comm., 34*, 569-586.

Gaston, A. J., Gilchrist, H. G., & Hipfner, J. M. (2005). Climate Change, Ice Conditions and Reproduction in an Arctic Nesting Marine Bird: Brunnich's Guillemot (Uria lomvia L.). *Journal of Animal Ecology, 74*(5), 832-841.

Gedamke, J., Gales, N. J., & Frydman, S. (2011). Assessing risk of baleen whale hearing loss from seismic surveys: The effect of uncertainty and individual variation. *Journal of Acoustic Society of America, 129*(1), 496-506.

Geernaert, T. O. (2013). Trends in seabird occurrence on stock assessment survyes (2002-2013). *IPHC Report of Assessment and Research Activities*, 441-450.

Gende, S. M., Hendrix, A. N., Harris, K. R., Eichenlaub, B., Nielsen, J., & Pyare, S. (2011). A Bayesian approach for understanding the role of ship speed in whale–ship encounters. *Ecological Applications, 21*(6), 2232-2240.

Georgette, S., & Loon, H. (1993). *Subsistence Use of Fish and Wildlife in Kotzebue, A Northwest Alaska Regional Center*. Juneau, Alaska: Alaska Department of Fish and Game.

Gerstein, E. (2002). Manatees, Bioacoustics and Boats Hearing tests, environmental measurements and acoustic phenomena may together explain why boats and animals collide. *American Scientist, 90*(2), 154-163.

Ghoul, A., & Reichmuth, C. (2014). Hearing in the sea otter (Enhydra lutris): auditory profiles for an amphibious marine carnivore. *Journal of Comparitive Physiology, 200*(11), 967.

Gill, R. E., Jr. , & Senner, S. (1996). Alaska and its importance to Western Hemisphere shorebirds. *International Wader Studies, 8*, 8-14.

Gilmore, R. (1976). Killer whales in the San Diego area, Del Mar to the Coronado Islands. *American Cetacean Society Newsletter, San Diego, California*.

Gilpatrick, J., & Perryman, W. L. (2008). Geographic variation in external morphology of North Pacific and Southern Hemisphere blue whales (Balaenoptera musculus). *Journal of Cetacean Research and Management, 10*(1), 9-21.

Gisiner, R. (1985). *MALE TERRITORIAL AND REPRODUCTIVE BEHAVIOR IN THE STELLER SEA LION, EUMETOPIAS JUBATUS (CALIFORNIA, ALASKA).*

Givens, G., Edmondson, S., George, J., Suydam, R., Charif, R., Rahaman, A., . . . Clark, C. (2013). Estimate of 2011 abundance of the Bering-Chukchi-Beaufort Seas bowhead whale population. *Paper SC/65a/BRG01 (Scientific Committee of the International Whaling Commission 65a, Jeju Island, Korea)*.

Glass, J. P., & Ryan, P. G. (2013). Reduced seabird night strikes and mortality in the Tristan rock lobster fishery. *African Journal of Marine Science, 35*(4), 589-592.

Goddard, P. D., & Rugh, D. J. (1998). A group of right whales seen in the Bering Sea in July 1996. *Marine Mammal Science, 14*(2), 344-349.

Godin, O. A. (2006). Anomalous transparency of water-air interface for lowfrequency sound *Physical Review Letters, 97*, 164301.

Goldbogen, J. A., Southall, B. L., DeRuiter, S. L., Calambokidis, J., Friedlaender, A. S., Hazen, E. L., . . . Moretti, D. J. (2013). *Blue whales respond to simulated mid-frequency military sonar.* Paper presented at the Proc. R. Soc. B.

Gómez-Gutiérrez, J., Peterson, W. T., & Miller, C. B. (2005). Cross-shelf life-stage segregation and community structure of the euphausiids off central Oregon (1970–1972). *Deep Sea Research Part II: Topical Studies in Oceanography, 52*(1–2), 289-315. doi: http://doi.org/10.1016/j.dsr2.2004.09.023.

Good, T. P., Waples, R. S., & Adams, P. (2005). *Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead*. NOAA Technical Memorandum NMFS-NWFSC-66, U.S. Department of Commerce. p. 598.

Goodall, C., Chapman, C., & Neil, D. (1990). *The acoustic response threshold of Norway lobster Nephrops norvegicus (L.) in a free found field*: Birkhäuser Basel.
Goold, J. C. (1999). Behavioral and acoustic observations of sperm whales in Scapa Flow, Orkney Islands. *Journal of the Marine Biological Association of the United Kingdom, 79*(3), 541-550.
Gorbics, C. S., & Bodkin, J. L. (2001). Stock Structure of Sea Otters (Enhydra lutris kenyoni) in Alaska. *17*(3), 632-647.
Gordon, J., Gillespie, D., Potter, J., Frantzis, A., Simmonds, M. P., Swift, R., & Tompson, D. (2004). A review of the effects of seismic surveys on marine mammals. *Marine Technology Society Journal, 37*(4), 16–34.
Gordon, J., Moscrop, A., Carlson, C., Ingram, S., Leaper, R., Matthews, J., & Young, K. (1998). *SC/49/O 27 Distribution, movements and residency of sperm whales off the Commonwealth of Dominica, Eastern Caribbean: implications for the development and regulation of the local whalewatching industry*. (0143-8700). International Whaling Commission. pp. 551-558.
Gordon, J. C. D., Leaper, R., Hartley, F. G., & Chappell, O. (1992). *Effects of whale watching vessels on the surface and acoustic behaviour of sperm whales off Kaikoura, New Zealand*. New Zealand Department of Conservation, Science and Research Series 52. p. 64.
Gorter, U., & Pitman, R. L. (2011). *Killer Whales: Ecotypes and forms*. La Jolla, CA: NOAA Fisheries, Southwest Fisheries Science Center.
Gosho, M. E., Gearin, P. J., Jenkinson, R., Laake, J. L., Mazzuca, L. L., Kubiak, D., . . . Deecke, V. B. (2011). *Movements and diet of gray whales (Eschrichtius robustus) off Kodiak Island, Alaska, 2002 – 2005*. (SC/M11/AWMP2). p. 12.
Gosho, M. E., Rice, D. W., & Breiwick, J. M. (1984). The sperm whale, Physeter macrocephalus. *Marine Fisheries Review, 46*(4), 54-64.
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.
Gradinger, R., Bluhm, B., & Iken, K. (2010). Arctic sea-ice ridges- Safe havens for sea-ice fauna during periods of extreme ice melt? *Deep-Sea Research II, 57*, 86-95.
Gray, L. M., & Greeley, D. S. (1980). Source level model for propeller blade rate radiation for the world's merchant fleet. *Journal of the Acoustical Society of America, 67*(2), 516-522.
Grebmeier, J. M., & Cooper, L. W. (1995). Influence on the St. Lawrence Island polynya upon the Bering Sea benthos. *Journal of Geophysical Research, 100*, 4439-4460.
Grebmeier, J. M., Feder, H. M., & McRoy, C. P. (1989). Pelagic-benthic coupling on the shelf of the northern Bering and Chukchi Seas. *Marine Ecology Progress Series, 11. Benthic community structure*(51), 253-268.
Green, E. P., & Short, F. T. (2003). *World Atlas of Seagrasses*. Berkeley, CA: University of California Press.
Green, G., Brueggeman, J. J., Grotefendt, R. A., Bowlby, C. E., Bonnell, M. L., & Balcomb, K. C. (1992). *Cetacean distribution and abundance off Oregon and Washington*. Los Angeles, CA: Minerals Management Service.

Green, G., Grotefendt, R. A., Smultea, M. A., Bowlby, C. E., & Rowlett, R. A. (1993). *Delphinid aerial surveys in Oregon and Washington waters*. Seattle, WA: Report prepared for NMFS.

Greene, C. H., Pershing, A. J., Kenney, R. D., & Jossi, J. W. (2003). BREAKING WAVES. *Oceanography, 16*(4), 98.

Gregr, E. J., & Coyle, K. O. (2009). The biogeography of the North Pacific right whale (Eubalaena japonica). *Progress in Oceanography, 80*(3), 188-198.

Gregr, E. J., Nichol, L. M., Ford, J. K. B., Ellis, G. M., & Trites, A. W. (2000). Migration and population structure of northeastern Pacific whales off coastal British Columbia: an analysis of commercial whaling records from 1908–1967. *16*(4), 699-727.

Grémillet, D., & Wilson, R. P. (1999). A life in the fast lane: energetics and foraging strategies of the great cormorant. *Behavioral Ecology, 10*(5), 516-524. doi: 10.1093/beheco/10.5.516.

Groot, C., & Margolis, L. (Eds.). (1991). *Pacific salmon life histories*. Vancouver, Canada: University of British Columbia Press.

Gudmundsson, G. A., Alerstam, T., Green, M., Hedenstr, xf, & m, A. (2002). Radar Observations of Arctic Bird Migration at the Northwest Passage, Canada. *Arctic, 55*(1), 21-43.

Guerrero-Ruiz, M., Gendron, D., & Urban, J. (1998). Distribution, movements and communities of killer whales (Orcinus orca) in the Gulf of California, Mexico. *Report of the International Whaling Commission, 48*, 537-543.

Guglielmo, L., Carrada, G., Catalano, G., Dell'Anno, A., Fabiano, M., Lazzara, L., . . . Saggiomo, V. (2000). Structural and functional properties of sympagic communities in the annual sea ice at Terra Nova Bay (Ross Sea, Antarctica). *Polar Biology, 23*(2), 137-146.

Gurevich, V. S. (1980). Worldwide distribution and migration patterns of the white whale (beluga), Delphinapterus leucas. *Rep. Int. Whal. Comm., 30*, 465-480.

Gustafson, R., Lee, Y., Ward, E., Somers, K., Tuttle, V., & Jannot, J. (2016). Status review update of eulachon (Thaleichthys pacificus) listed under the Endangered Species Act: southern distinct population segment. 25 March 2016 Report to National Marine Fisheries Service–West Coast Region from Northwest Fisheries Science Center, 2725 Montlake Blvd. *E., Seattle, WA, 98112*, 222-234.

Guy, L. S., Duffy-Anderson, J., Matarese, A. C., Mordy, C. W., Napp, J. M., & Stabeno, P. J. (2014). Understanding Climate Control of Fisheries Recruitment in the Eastern Bering Sea. *Oceanography, 27*(4), 90.

Hain, J. H., Ellis, S. L., Kenney, R. D., Clapham, P. J., Gray, B. K., Weinrich, M. T., & Babb, I. G. (1995). Apparent bottom feeding by humpback whales on Stellwagen Bank. *Marine Mammal Science, 11*(4), 464-479.

Hamernik, R. P., & Hsueh, K. D. (1991). Impulse noise: some definitions, physical acoustics and other considerations. [special]. *The Journal of Acoustical Society of America, 90*(1), 189–196.

Hamilton, C. D., Lydersen, C., Ims, R. A., & Kovacs, K. M. (2015). Predictions replaced by facts: a keystone species' behavioural responses to declining arctic sea-ice. *Biology Letters, 11*(11). doi: 10.1098/rsbl.2015.0803.

Hamilton, W. J. (1958). Pelagic birds observed on a North Pacific crossing. *The Condor, 60*(3), 159-164.

Hammill, M., Lydersen, C., Ryg, M., & Smith, T. (1991). Lactation in the ringed seal (Phoca hispida). *Canadian Journal of Fisheries and Aquatic Sciences, 48*(12), 2471-2476.

Hammill, M., & Smith, T. (1989). Factors affecting the distribution and abundance of ringed seal structures in Barrow Strait, Northwest Territories. *Canadian Journal of Zoology, 67*(9), 2212-2219.

Handegard, N. O., Michalsen, K., & Tjøstheim, D. (2003). Avoidance behaviour in cod (Gadus morhua) to a bottom-trawling vessel. *Aquatic Living Resources, 16*(3), 265-270.

Hanlon, R. T. (1987). Why cephalods are probably not deaf. *The American Naturalist, 129*(2), 312 - 317.

Hanna, G. D. (1920). Mammals of the St. Matthew Islands, Bering Sea. *Journal of Mammalogy, 1*(3), 118-122.

Hannach, G., & Swanson, L. M. (2017). A Long-term Phytoplankton Monitoring Program for Central Puget Sound using Particle Imaging.

Hansen, K. A., Maxwell, A., Siebert, U., Larsen, O. N., & Wahlberg, M. (2017). Great cormorants (*Phalacrocorax carbo*) can detect auditory cues while diving. *The Science of Nature*(104), 5-6.

Harding, G. C. (1966). *Zooplankton distribution in the Arctic Ocean with notes of life cycles.* Masters of Science, McGill University.

Harington, C. R. (1968). *Denning habits of the polar bear (Ursus maritimus Phipps)*. (Series 5). Canadian Wildlife Service Report. p. 33.

Harper, W. L., Schroeder, B. K., Manley, I. A., & Deal, J. A. (2004, 2-6 March 2004). *Radar monitoring of marbled murrelet populations at inland sites on northern Vancouver Island.* Paper presented at the Species at Risk 2004: Pathways to Recovery Conference, Victoria, B.C.

Harwood, L. A., Smith, T. G., & Auld, J. C. (2012). Fall migration of ringed seals (Phoca hispida) through the Beaufort and Chukchi Seas, 2001 - 02. *65*(1), 35-44.

Harwood, L. A., Smith, T. G., George, J. C., Sandstrom, S. J., Walkusz, W., & Divoky, G. J. (2015). Change in the Beaufort Sea ecosystem: Diverging trends in body condition and/or production in five marine vertebrate species. *136*, 263-273.

Harwood, L. A., & Stirling, I. (1992). Distribution of ringed seals in the southeastern Beaufort Sea during late summer. *70*, 891-900.

Hashagen, K. A., Green, G. A., & Adams, B. (2009). Observations of humpback whales, Megaptera novaeangliae, in the Beaufort Sea, Alaska. *Northwestern Naturalist, 90*(2), 160-162.

Hashino, E., Sokabe, M., & Miyamoto, K. (1988). Frequency specific susceptibility to acoustic trauma in the budgerigar (M. elopsittacusundulatus). *The Journal of the Acoustical Society of America*(6), 2450-2453.

Hastings, M. C., & Popper, A. N. (2005). *Effects of sound on fish*. Sacramento, CA: Jones & Stokes for the California Department of Transportation. p. 82.

Hatch, L. T., Clark, C. W., Van Parijs, S. M., Frankel, A. S., & Ponirakis, D. W. (2012). Quantifying Loss of Acoustic Communication Space for Right Whales in and around a U.S. National Marine Sanctuary. *Conservation Biology, 26*(6), 983-994. doi: 10.1111/j.1523-1739.2012.01908.x.

Hawkins, A. D., & Johnstone, A. D. F. (1978). The hearing of the Atlantic Salmon, *Salmo salar*. *Journal of Fish Biology, 13*(6), 655-673.

Hawkins, P. A. J., Butler, P. J., Woakes, A. J., & Speakman, J. R. (2000). Estimation of the rate of oxygen consumption of the common eider duck (*Somateria mollissima*), with some measurements of heart rate during voluntary dive. *The Journal of Experimental Biology*(203), 2819-2832.

Hay, R. B. (1992). The Oceanic Habitats of Seabirds: Their Zonal Distribution Off Vancouver Island, British Columbia, Canada. *Journal of Biogeography, 19*(1), 67-85. doi: 10.2307/2845621.

Hazard, K. (1988). Beluga whale, Delphinapterus leucas. In. Lentfer, J. W. (Ed.), *Selected marine mammals of Alaska. Species accounts with research and management recommendations*. Washington, D.C.: Marine Mammal Commission.

Hazel, J., Lawler, I. R., Marsh, H., & Robson, S. (2007). Vessel Speed Increases Collision Risk for the Green Turtle *Chelonia mydas*. *Endangered Species Research, 3*, 105-113.

Heath, J. P., Gilchrist, H. G., & Ydenberg, R. C. (2007). Can dive cycle models predict patterns of foraging behaviour? Diving by common eiders in an Arctic polynya. *Animal Behaviour, 73*(5), 877-884. doi: https://doi.org/10.1016/j.anbehav.2006.10.015.

Heide-Jørgensen, M., Laidre, K., Wiig, Ø., Postma, L., Dueck, L., & Bachmann, L. (2010). Large-scale sexual segregation of bowhead whales. *Endangered Species Research, 13*(1), 73-78.

Heide-JØrgensen, M. P., Laidre, K., Jensen, M. V., Dueck, L., & Postma, L. (2006). Dissolving stock discreteness with satellite tracking: bowhead whales in Baffin Bay. *Marine Mammal Science, 22*(1), 34-45.

Helfman, G. S. (2009). *The diversity of fishes: Biology, evolution, and ecology*. Hoboken, NJ: Wiley Blackwell.

Helm, R. C., Costa, D. P., DeBruyn, D. T., O'Shea, T. J., Wells, R. S., & Williams, T. M. (2015). Overview of effects of oil spills on marine mammals. In. Fingas, M. (Ed.), *Handbook of oil spill science and technology* (pp. 456-475). New Jersey: John Wiley & Sons, Inc.

Hemila, S., Nummela, S., Berta, A., & Reuter, T. (2006). High-frequency hearing in phocid and otariid pinnipeds: An interpretation based on inertial and cochlear constraints (L). *Journal of the Acoustical Society of America, 120*(6), 3463-3466.

Henninger, H. P., & Watson, W. H. (2005). Mechanisms underlying the production of carapace vibrations and associated waterborne sounds in the American lobster, *Homarus americanus*. *Journal of Experimental Biology, 208*(17), 3421-3429.

Henry, E., & Hammill, M. O. (2001). Impact of small boats on the haulout activity of harbour seals (Phoca vitulina) in Metis Bay, Saint Lawrence Estuary, Quebec, Canada. *Aquatic Mammals, 27*(2), 140-148.

Heptner, L. V., Chapskii, K. K., Arsen'ev, V. A., & Sokolov, V. T. (1976). Bearded seal. *Erignathus barbatus* (Erxleben, 1777). In (Translated from Russian by P. M. Rao, Science Publishers, Inc., Lebanon, NH, Trans.). Heptner, L. V. G., Naumov, N. P. & Mead, J. G. (Eds.), *Mammals of the Soviet Union* (Vol. II, Part 3-- Pinnipeds and Toothed Whales, Pinnipedia and Odontoceti.). Moscow, Russia: Vysshaya Shkola Publishers.

Hertel, H. (1969). Hydrodynamics of swimming and wave-riding dolphins. *The Biology of Marine Mammals*, 31-63.

Hewitt, R. P. (1985). Reactions of dolphins to a survey vessel: Effects on census data. *Fisheries Bulletin, 83*(2), 187-193.

Hickey, B., Geier, S., Kachel, N., & MacFadyen, A. (2005). A bi-directional river plume: The Columbia in summer. *Continental Shelf Research, 25*(14), 1631-1656. doi: http://doi.org/10.1016/j.csr.2005.04.010.

Hilcorp Alaska. (2015). *Liberty development project development and production plan Revision 1. Prepared by Hilcorp Alaska, LLC. Anchorage, AK and submitted to Bureau of Ocean Energy Management - Alaska OCS Region, Anchorage, AK.* Anchorage, AK. 288 pp.

Hildebrand, J. A. (2009). Anthropogenic and natural sources of ambient noise in the ocean. *Marine Ecology Progress Series, 395*, 5-20.

Hill, P. S., & Barlow, J. (1992). Report of a marine mammal survey of the California coast aboard the research vessel McArthur, July 28-November 5, 1991.

Hobbs, R. C., & Waite, J. M. (2010). Abundance of harbor porpoise (Phocoena phocoena) in three Alaskan regions, corrected for observer errors due to perception bias and species misidentification, and corrected for animals submerged from view. *Fishery Bulletin, 108*(3), 251-267.

Hodge, R. P., & Rabe, M. (2008). Turtles - Alaska Department of Fish and Game Wildlife Notebook Series. Retrieved from www.adfg.alaska.gov/static-f/education/wns/turtles.pdf

Hodge, R. P., & Wing, B. L. (2000). Occurrences of Marine Turtles in Alaska Waters: 1960-1998. *Herpetological Review, 31*(3), 148-151.

Hogan, C. (2011). California Current large marine ecosystem. *The Encyclopedia of Earth* Retrieved from http://www.eoearth.org/view/article/150853

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. *17*(4), 888-908.

Holt, M., Veirs, V., & Veirs, S. (2008). Investigating noise effects on the call amplitude of endangered Southern Resident killer whales (Orcinus orca). *Journal of the Acoustical Society of America, 123*(5), 2985-2985.

Holt, M. M., Noren, D. P., & Emmons, C. K. (2011). Effects of Noise Levels and Call Types on the Source Levels of Killer Whale Calls. *Journal of the Acoustical Society of America, 130*(5), 3100-3106.

Holt, M. M., Schusterman, R. J., Southall, B. L., & Kastak, D. (2004). Localization of aerial broadband noise by pinnipeds. *The Journal of the Acoustical Society of America, 115*(5), 2339-2345.

Hopcroft, R., Bluhm, B., & Gradinger, R. (2008). *Arctic Ocean synthesis: Analysis of climate change impacts in the Chukchi and Beaufort Seas with strategies for future research*. Fairbanks, AK. p. 184.

Horner, R., & Schrader, G. C. (1982). Relative Contributions of Ice Algae, Phytoplankton, and Benthic Microalgae to Primary Production in Nearshore Regions of the Beaufort Sea. *Arctic, 35*(4), 485-503.

Horwood, J. (1987). *The sei whale: Population biology, ecology & management*: Routledge.

Houser, D. S., Helweg, D. A., & Moore, P. W. B. (2001a). A bandpass filter-bank model of auditory sensitivity in the humpback whale. *27*(2), 82-91.

Houser, D. S., Howard, R., & Ridgway, S. H. (2001b). Can diving-induced tissue nitrogen supersaturation increase the chance of acoustically driven bubble growth in marine mammals? *, 213*, 183-195.

Hu, M. Y., Yan, H. Y., Chung, W.-S., Shiao, J.-C., & Hwang, P.-P. (2009). Acoustically evoked potentials in two cephalopods inferred using the auditory brainstem response (ABR) approach. *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology, 153*(3), 278-283. doi: 10.1016/j.cbpa.2009.02.040.

Hubbard Jr, L. T., & Pearcy, W. G. (1971). Geographic distribution and relative abundance of Salpidae off the Oregon coast. *Journal of the Fisheries Board of Canada, 28*(12), 1831-1836.

Huelsbeck, D. R. (1988). Whaling in the pre-contact economy of the central northwest coast *Arctic Anthropology, 25*(1), 1-15.

Hughes, G. R., Luschi, P., Mencacci, R., & Papi, F. (1998). The 7000-km oceanic journey of a leatherback turtle tracked by satellite. *Journal of Experimental Marine Biology and Ecology, 229*(2), 209-217. doi: https://doi.org/10.1016/S0022-0981(98)00052-5.

Huntington, H. P., Daniel, R., Hartsig, A., Harun, K., Heiman, M., Meehan, R., . . . Stetson, G. (2015). Vessels, Risks, and Rules: Planning for Safe Shipping in Bering Strait. *Marine Policy, 51*, 119-127.

Huntington, H. P., Quakenbush, L. T., & Nelson, M. (2016). Effects of changing sea ice on marine mammals and subsistence hunters in northern Alaska from traditional knowledge interviews. *Biology Letters, 12*(8). doi: 10.1098/rsbl.2016.0198.

Hyrenbach, K. D. (2001). Albatross response to survey vessels: implications for studies of the distribution, abundance, and prey consumption of seabird populations. *Marine Ecology Progress Series, 212*, 283-295.

Hyrenbach, K. D., Keiper, C., Allen, S. G., Ainley, D. G., & Anderson, D. J. (2006). Use of marine sanctuaries by far-ranging predators: commuting flights to the California Current System by breeding Hawaiian albatrosses. *Fisheries Oceanography, 15*(2), 95-103.

Ice Seal Committee. (2016). *The Subsistence Harvest of Ice Seals in Alaska-A Compilation of Existing Information, 1960-2014* p. 76 p.

Ichihara, T. (1966). The pygmy blue whale, Balaenoptera musculus brevicauda, a new subspecies from the Antarctic. *Whales, dolphins and porpoises, 9*, 79-111.

Iñíguez, M., Masello, J. F., Arcucci, D., Krohling, F., & Belgrano, J. (2010). On the occurrence of sei whales, Balaenoptera borealis, in the south-western Atlantic. *Marine Biodiversity Records, 3*, e68.

International Association of Antarctica Tour Operators. (2017). Tourism Statistics Retrieved from https://iaato.org/tourism-statistics as accessed on 21 April 2017.

International Court of Justice (ICJ). (2014). *Whaling in the Antarctic (Australia v. Japan: New Zealand intervening) Summary of the Judgment of 31 March 2014*. The Hague, Netherlands. http://www.icj-cij.org/docket/files/148/18160.pdf.

International Union for the Conservation of Nature. (2016). *Phoebastria albatrus* Retrieved from http://www.iucnredlist.org/details/22698335/0 as accessed on 03 March 2017.

Ivashchenko, Y. V., Brownell Jr, R. L., & Clapham, P. J. (2014). Distribution of Soviet catches of sperm whales Physeter macrocephalus in the North Pacific. *Endangered Species Research, 25*(3), 249-263.

Ivashin, M. V., & Votrogov, L. M. (1981). *Killer whales, Orcinus orca, inhabiting inshore waters of the Chukotka coast*. p. 521.

Iverson, G. C., Warnock, S. E., Butler, R. W., Bishop, M. A., & Warnock, N. (1996). Spring migration of western sandpipers along the Pacific coast of North America: a telemetry study. *Condor*, 10-21.

IWC. (1982). *Report of the Subcommittee on sperm whales*. pp. 68-86.

IWC. (1991). Annex E. Report of the sub-committee on southern hemisphere minke whales. *Rep. Int. Whal. Comm., 41*, 113-131.

IWC. (1996). *Report of the scientific committee*. International Whaling Commission. pp. 72-77.

IWC. (2001). Report of the workshop on the comprehensive assessement of right whales: a worldwide comparison. *Journal of Cetacean Research and Management, Special Issue*(2), 1-56.

IWC. (2007). *Report of the Report of the Sub-Committee on Estimation of Bycatch and Other Human-Induced Mortality. Map of reported by-catch locations for period July 2001 to September 2005*.

IWC. (2008). Annex F: Report of the sub-committee on bowhead, right and gray whales. *J Cetacean Res Manag Suppl, 10*, 150-166.

IWC. (2010). Report of the workshop on cetaceans and climate change. *J Cetacean Res Manag Suppl, 11*(2), 451-480.

IWC. (2012a). *Annual Report of the International Whaling Commission*. (1561-0721). Cambridge, UK.

IWC. (2012b). Report of the Scientific Committee. *Journal of Cetacean Research and Management, 13*.

IWC. (2014). Report of the Scientific Committee. *Journal of Cetacean Research and Management, 15 (Suppl.)*.

IWC. (2017). Special Permit Whaling Retrieved from https://iwc.int/permits. as accessed on 27 February 2017.

Jaquet, N., Gendron, D., & Coakes, A. (2003). Sperm whales in the Gulf of California: residency, movements, behavior, and the possible influence of variation in food supply. *Marine Mammal Science, 19*(3), 545-562.

Jefferson, T. A., Hung, S. K., & Wursig, B. (2009). Protecting small cetaceans from coastal development: Impact assessment and mitigation experience in Hong Kong. *Marine Policy, 33*(2), 305-311.

Jefferson, T. A., Smultea, M. A., & Bacon, C. E. (2014). Southern California Bight marine mammal density and abundance from aerial surveys 2008-2013. *Journal of Marine Animals and Their Ecology, 2*(2).

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.

Jefferson, T. A., Webber, M. A., & Pitman, R. L. (Eds.). (2015). *Marine Mammals of the World: A Comprehensive Guide to Their Identification* (2nd Ed. ed.). London: Elsevier/Academic Press.

Jemison, L. A., Pendleton, G. W., Fritz, L. W., Hastings, K. K., Maniscalco, J. M., Trites, A. W., & Gelatt, T. S. (2013). Inter-population movements of steller sea lions in Alaska with implications for population separation. *8*(8), e70167.

Jensen, A. S., & Silber, G. K. (2003). *Large whale ship strike database*. (NOAA Technical Memorandum NMFS-OPR). National Oceanic and Atmospheric Administration (NOAA).
Johannesen, E., Høines, Å. S., Dolgov, A. V., & Fossheim, M. (2012). Demersal Fish Assemblages and Spatial Diversity Patterns in the Arctic-Atlantic Transition Zone in the Barents Sea. *PLoS ONE, 7*(4), e34924. doi: 10.1371/journal.pone.0034924.
Johnson, A., & Acevedo-Gutiérrez, A. (2007). Regulation compliance by vessels and disturbance of harbour seals (*Phoca vitulina*). *Canadian Journal of Zoology, 85*, 290-294. doi: 10.1139/Z06-213.
Johnson, D. S., & Fritz, L. W. (2014). agTrend: a method for estimating trend of aggregated animal counts at sites with different survey histories. *Methods in Ecology and Evolution*.
Johnson, J. H., & Wolman, A. A. (1984). The humpback whale, Megaptera novaeangliae. *Marine Fisheries Review, 46*(4), 30-37.
Johnson, M. L., Fiscus, C. H., Stenson, B. T., & Barbour, M. L. (1966). Marine Mammals. In. Wilimovsky, N. J. & Wolfe, J. N. (Eds.), *Environment of the Cape Thompson Region, Alaska* (pp. 877-924). Oak Ridge, TN: U.S. Atomic Energy Commission.
Jorgensen, R., Handegard, N. O., Gjosaeter, H., & Slotte, A. (2004). Possible vessel aviodance behavior of capelin in a feeding area and on a spawning ground. *Fisheries Research, 69*(2), 251-261.
Josefson, A. B., Mokievsky, V., Bergmann, M., Blicher, M. E., Bluhm, B., Cochrane, S., . . . Włodarska-Kowalczuk, M. (2013). Marine invertebrates. In. Meltofte, H. (Ed.), *Arctic biodiversity assessment* (pp. 225-257). Denmark: Conservation of Arctic Flora and Fauna (CAFF), Arctic Council.
Kaifu, K., Akamatsu, T., & Segawa, S. (2008). Underwater sound detection by cephalopod statocyst. *Fisheries Science, 74*, 781-786.
Kajimura, H., & Loughlin, T. R. (1988). Marine mammals in the oceanic food web of the eastern subarctic Pacific. *Bulletin of the Ocean Research Institute, University of Tokyo, 26*, 187-223.
Kaplan, B., Beegle-Krause, C., French McCay, D., Copping, A., & Geerlofs, S. (2010). *Updated Summary of Knowledge: Selected Areas of the Pacific Coast.* Camarillo, CA: U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region. OCS Study BOEMRE 2010-014. .
Karl, T. R., Melillo, J. M., & Peterson, T. C. (Eds.). (2007). *Global Climate Change Impacts in the United States*. New York, NY: Cambridge University Press.
Kaschner, K. J., Watson, R., Trites, A. W., & Pauly, D. (2006). Mapping world-wide distributions of marine mammal species using a relative environmental suitability (RES) model. *Marine Ecology Progress Series, 316*, 285-310.
Kastak, D., & Schusterman, R. J. (1998). Low-frequency amphibious hearing in pinnipeds: methods, measurements, noise, and ecology. *Journal of the Acoustical Society of America, 103*(4), 2216-2228.
Kastak, D., Southall, B., Holt, M., Reichmuth Kastak, C., & Schusterman, R. (2004). Noise-induced temporary threshold shifts in pinnipeds: Effects of noise energy. *The Journal of the Acoustical Society of America, 116*(4), 2531-2532.

Kastak, D., Southall, B. L., Schusterman, R. J., & Kastak, C. R. (2005). Underwater temporary threshold shift in pinnipeds: Effects of noise level and duration. *The Journal of the Acoustical Society of America, 118*(5), 3154-3163.

Kastelein, R. A. (2009). Walrus *Odobenus rosmarus*. In In. Perrin, W. F., Wursig, B. & Thewissen, J. G. M. (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 1212-1217). Amsterdam, The Netherlands: Academic Press.

Kastelein, R. A., Bunskoek, P., Hagedoorn, M., Au, W. W., & De Haan, D. (2002a). Audiogram of a harbor porpoise (*Phocoena phocoena*) measured with narrow-band frequency-modulated signals. *The Journal of the Acoustical Society of America, 112*(1), 334-344.

Kastelein, R. A., Mosterd, P., Santen, B. v., Hagedoorn, M., & Haan, D. d. (2002b). Underwater Audiogram of a Pacific Walrus (Odobenus rosmarus divergens) Measured with Narrow-Band Frequency-Modulated Signals. *Journal of the Acoustical Society of America, 112*(5 Pt. 1), 2173-2182.

Kastelein, R. A., Postma, J., Van Rossum, T., & Wiepkema, P. R. (1996). Drinking speed of Pacific walrus (*Odobenus rosmarus divergens*) pups. *Aquatic Mammals, 11*(1), 21-26.

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

Kasuya, T. (1971). Consideration of distribution and migration of toothed whales off the Pacific coast of Japan based upon aerial sighting record. *Sci. Rep. Whales Res. Inst, 23*, 37-60.

Kasuya, T. (2009). Giant beaked whales. In. Perrin, W. F., Wursig, B. & Thewissen, J. G. M. (Eds.), *Encyclopedia of marine mammals* (pp. 498-500). San Diego, CA: Academic Press.

Kasuya, T., & Miyashita, T. (1988). Distribution of sperm whale stocks in the North Pacific. *Scientific Reports of the Whales Research Institute, Tokyo, 39*, 31-75.

Kawamura, A. (1982). Food habits and prey distributions of three rorqual species in the North Pacific Ocean. *Scientific Reports of the Whales Research Institute, Tokyo, 34*, 59-91.

Keefer, M. L., Peer, C. A., & Caudill, C. C. (2008). Migration timing of Columbia River spring Chinook salmon: effects of temperature, river discharge, and ocean environment. *Transactions of the American Fisheries Society, 137.4*, 1120-1133.

Keenan, R. E., & Gainey, L. (2015). *U.S. Navy Acoustic Effects Model (NAEMO) Acoustic Propagation Analysis Process Review Final Report*. p. 83 pp.

Kelly, B. P. (1988). *Bearded seal, Erignathus barbatus*. Washington, D.C.: Marine Mammal Commission.

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

Kennedy, A. S., Salden, D. R., & Clapham, P. J. (2012). First high-to low-latitude match of an eastern North Pacific right whale (Eubalaena japonica). *Marine Mammal Science, 28*(4), E539-E544.

Kennett, J. P. (1982). Marine Geology.

Kenney, R. (1998). *Global climate change and whales: western North Atlantic right whale calving rate correlates with the Southern Oscillation Index. International Whaling Commission, Cambridge, UK. Doc.* Paper presented at the International Whaling Commission Workshop on the Comprehensive Assessment of Right Whales: A Worldwide Comparison, Monkey Valley, South Africa.

Kenyon, K. W., & Rice, D. W. (1961). Abundance and distribution of the Steller sea lion. *42*(2), 223-234.

Kertell, K. (1991). Disappearance of the Steller's eider for the Yukon-Kuskokwim Delta, Alaska. *Arctic, 44*(3), 177-187.

Ketten, D. R. (1992a). The Cetacean Ear: Form, Frequency, and Evolution. In *Marine Mammal Sensory Systems* (pp. 53-76). New York: Plenum Press.

Ketten, D. R. (1992b). The Marine Mammal Ear: Specializations for Aquatic Audition and Echolocation. In *The Evolutionary Biology of Hearing* (pp. 717-754). Berlin: Springer-Verlag.

Ketten, D. R. (1994). Functional Analyses of Whale Ears: Adaptations for Underwater Hearing. *1*, 264-270.

Ketten, D. R., & Mountain, D. C. (2009). Beaked and baleen whale hearing: modeling responses to underwater noise.

King, J. E. (1983). *Seals of the world* (Second Edition ed.). London, UK: British Museum (Natural History) and Oxford University Press.

Kistchinski, A. A., & Flint, V. E. (1974). On the biology of the spectacled eider. *Wildfowl, 25*, 5-15.

Klanjscek, T., Nisbet, R. M., Caswell, H., & Neubert, M. G. (2007). A model for energetics and bioaccumulation in marine mammals with applications to the right whale. *Ecological Applications, 17*(8), 2233-2250.

Knowlton, A. R., & Kraus, S. D. (2001). Mortality and serious injury of northern right whales (Eubalaena glacialis) in the western North Atlantic Ocean. *Journal of Cetacean Research and Management (special issue), 2*, 193-208.

Kohlbach, D., Graeve, M., A. Lange, B., David, C., Peeken, I., & Flores, H. (2016). The importance of ice algae-produced carbon in the central Arctic Ocean ecosystem: Food web relationships revealed by lipid and stable isotope analyses. *Limnology and Oceanography, 61*(6), 2027-2044. doi: 10.1002/lno.10351.

Kojima, S. (2002). Deep-sea chemoautosynthesis-based communities in the northwestern Pacific. *Journal of Oceanography, 58*, 343-363.

Komenda-Zehnder, S., Cevallos, M., & Bruderer, B. (2003). Effects of disturbance by aircraft overflight on waterbirds–an experimental approach. *Proceedings International Bird Strike Committee May*.

Konar, B., Iken, K., & Edwards, M. (2009). Depth-stratified community zonation patterns on Gulf of Alaska rocky shores. *Marine Ecology, 30*(1), 63-73.

Konishi, K., Tamura, T., Zenitani, R., Bando, T., Kato, H., & Walløe, L. (2008). Decline in energy storage in the Antarctic minke whale (Balaenoptera bonaerensis) in the Southern Ocean. [journal article]. *Polar Biology, 31*(12), 1509-1520. doi: 10.1007/s00300-008-0491-3.

Kooyman, G. L., & Kooyman, T. G. (1995). Diving Behavior of Emperor Penguins Nurturing Chicks at Coulman Island, Antarctica. *The Condor, 97*(2), 536-549. doi: 10.2307/1369039.

Kopp, M., Peter, H.-U., Mustafa, O., Lisovski, S., Ritz, M. S., Phillips, R. A., & Hahn, S. (2011). South polar skuas from a single breeding population overwinter in different oceans though show similar migration patterns. *Marine Ecology Progress Series, 435*, 263-267.

Koski, W. R., & Johnson, S. R. (1987). *Behavioral studies and aerial photogrammetry: Sect. 4 In: Responses of bowhead whales to an offshore drilling operation in the Alaskan Beaufort Sea, autumn 1986*. Report from LGL Ltd, King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for Shell Western Expl. & Prod. Inc., Anchorage, AK. p. 371.

Kosobokova, K. N., & Hopcroft, R. R. (2010). Diversity and vertical distribution of mesozooplankton in the Arctic's Canada Basin. *Deep-Sea Research II, 57*, 96-110.

Kovacs, A., & Mellor, M. (1974). Sea ice morphology and ice as a geologic agent in the southern Beaufort Sea. *In: The coast and shelf of the Beaufort Sea*.

Kovacs K.M., Lydersen, C., Overland, J. E., & Moore, S. E. (2011). Impacts of changing sea-ice conditions on Arctic marine mammals. *Marine Biodiversity*(41), 181–194.

Krahn, M. M., Ford, M. J., Perrin, W. F., Wade, P. R., Angliss, R. P., Hanson, M. B., . . . Waples, R. S. (2004). *2004 status review of southern resident killer whales (Orcinus orca) under the Endangered Species Act*. Seattle, WA: U.S. Department of Commerce.

Krahn, M. M., Wade, P. R., Kalinowski, S. T., Dahlheim, M. E., Taylor, B. L., Hanson, M. B., . . . Waples, R. S. (2002). *Status review of southern resident killer whales (Orcinus orca) under the Endangered Species Act*. Seattle, WA: U.S. Department of Commerce.

Kraig, E., & Scalici, T. (2017). *Washington State Sport Catch Report 2015*. Olympia, WA: Washington State Department of Fish and Wildlife.

Kramer, M., Swadling, K. M., Meiners, K. M., Kiko, R., Scheltz, A., Nicolaus, M., & Werner, I. (2011). Antarctic sympagic meiofauna in winter: Comparing diversity, abundance and biomass between perennially and seasonally ice-covered regions. *Deep Sea Research Part II: Topical Studies in Oceanography, 58*(9–10), 1062-1074. doi: http://dx.doi.org/10.1016/j.dsr2.2010.10.029.

Kraus, S. D., Prescott, J. H., Knowlton, A., & Stone, G. S. (1986). Migration and calving of right whales (Eubalaena glacialis) in the western North Atlantic. *Report of the International Whaling Commission (Special Issue 10)*, 139-144.

Krieger, K., & Wing, B. L. (1984). *Hydroacoustic surveys and identification of humpback whale forage in Glacier Bay, Stephens Passage and Frederick Sound, southeastern Alaska, Summer 1983*. NMFS Auke Bay Lab.

Krieger, K., & Wing, B. L. (1986). *Hyroacoustic monitoring of prey to determine humpback whale movements*. NOAA Tech. Memo. NMFS F/NWC-66, NMFS Auke Bay Lab., Juneau, AK. p. 62.

Krijgsveld, K., Lensink, R., Schekkerman, H., Wiersma, P., Poot, M., Meesters, E., & Dirksen, S. (2005). *Baseline studies North Sea Wind Farms: Fluxes, Flight Paths and Altitudes of Flying Birds 2003-2004*. National Institute for Coastal and Marine Management (RIKZ).

Kuker, K. J., Thomson, J. A., & Tscherter, U. (2005). Novel surface feeding tactics of minke whales, Balaenoptera acutorostrata, in the Saguenay-St. Lawrence National Marine Park. *The Canadian Field Naturalist, 119*(2), 214-218.

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.

La Mesa, M., & Eastman, J. T. (2012). Antarctic silverfish: life strategies of a key species in the high-Antarctic ecosystem. *Fish and Fisheries, 13*(3), 241-266.

Laidre, K. L., Stern, H., Kovacs, K. M., Lowry, L., Moore, S. E., Regehr, E. V., . . . Ugarte, F. (2015). Arctic marine mammal population status, sea ice habitat loss, and conservation recommendations for the 21st century. *Conservation Biology, 29*(3), 724–737. doi: 10.1111/cobi.12474.

Laist, D., & Shaw, C. (2006). Preliminary evidence that boat speed restrictions reduce deaths of Florida manatees. *Marine Mammal Science, 22*, 472-479.

Laist, D. W. (1997). Impacts of marine debris: entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. In *Marine Debris* (pp. 99-139): Springer.

Laist, D. W., Knowlton, A. R., Mead, J. G., Collet, A. S., & Podesta, M. (2001). Collisions between ships and whales. *Marine Mammal Science, 17*(1), 35-75.

Landry, M., & Lorenzen, C. (1989). Abundance, distribution, and grazing impact of zooplankton on the Washington shelf. *Elsevier Oceanography Series, 47*, 175-210.

Lang, A., Weller, D., LeDuc, R., Burdin, A., Pease, V., Litovka, D., . . . Brownell Jr, R. (2011). *Genetic analysis of stock structure and movements of gray whales in the eastern and western North Pacific.* Paper presented at the 19th Biennial Conference on the Biology of Marine Mammals. Tampa, Florida.

Lang, A. R. (2010). *The population genetics of gray whales (Eschrichtius robustus) in the North Pacific*. (Ph.D.dissertation). University of California San Diego. p. 222.

Lang, T. G. (1966). Hydrodynamic analysis of cetacean performance. *Whales, dolphins and porpoises*, 410-432.

Leatherwood, S. (1988). *Whales, dolphins, and porpoises of the eastern North Pacific and adjacent Arctic waters: A guide to their identification*: Courier Corporation.

LeDuc, R., Perryman, W., Gilpatrick, J., Hyde, J., Stinchcomb, C., Carretta, J., & Brownell Jr, R. (2001). A note on recent surveys for right whales in the southeastern Bering Sea. *Journal of Cetacean Research and Management, 2*, 287-289.

LeDuc, R. G., Weller, D. W., Hyde, J., Burdin, A. M., Rosel, P. E., Brownell Jr., R. L., . . . Dizon, A. E. (2002). Genetic differences between western and eastern North Pacific gray whales (Eschrichtius robustus). *Journal of Cetacean Research and Management, 4*(1), 1-5.

Leet, W. S., Dewees, C. M., Klingbeil, R., & Larson, E. J. (2001). *California's Living Marine Resources: A Status Report*. California Department of Fish and Game. p. 593.

Leidy, R. A. (2000). Steelhead. In. Olofoson, P. R. (Ed.), *Baylands Ecosystem Species and Community Profiles: Life Histories and Environmental Requirements of Key Plants, Fish and Wildlife* (pp. 101-104). Oakland, CA: San Francisco Bay Area Wetlands Ecosystem Goals Project.

Lenhardt, M. (2002). Sea turtle auditory behavior. *The Journal of the Acoustical Society of America, 112*(5), 2314-2314.

Lenhardt, M., Moein, S., & Musick, J. (1996). *A method for determining hearing thresholds in marine turtles.* Paper presented at the Proceedings of the fifteenth annual symposium on sea turtle biology and conservation. NOAA Technical Memorandum NMFS-SEFSC-387.

Lenhardt, M. L., Bellmund, S., Byles, R. A., Harkins, S. W., & Musick, J. A. (1983). Marine turtle reception of bone-conducted sound. *Journal of Auditory Research, 23*, 119-125.

Lenhardt, M. L., Klinger, R. E. C., & Musick, J. A. (1985). Marine Turtle Middle-Ear Anatomy. *The Journal of Auditory Research, 25*, 66-72.

Levinton, J. (2009). The Water Column: Plankton. In *Marine Biology: Function, Biodiversity, Ecology* (3rd ed., pp. 167-186). New York, NY: Oxford University Press.

Linacre, L. (2004). *Community Structure of Euphausids in the Southern Part of the California Current During October 1997 (El Nino) and October 1998 (La Nina)*. pp. 126-136.

Ljungblad, D. K., & Moore, S. E. (1983). Killer whales (Orcinus orca) chasing gray whales (Eschrichtius robustus) in the northern Bering Sea. *Arctic, 36*(4), 361-364.

Logerwell, E., Busby, M., Carothers, C., Cotton, S., Duffy-Anderson, J., Farley, E., . . . Sformo, T. (2015). Fish communities across a spectrum of habitats in the western Beaufort Sea and Chukchi Sea. *Progress in Oceanography, 136*, 115-132.

Lohmann, K., & Lohmann, C. M. F. (1996). Detection of magnetic field intensity by sea turtles. *Nature, 380*(7), 59-61.

Lønne, O. J., & Gabrielsen, G. W. (1992). Summer diet of seabirds feeding in sea-ice-covered waters near Svalbard. *Polar Biology, 12*(8), 685-692.

Loughlin, T. R., (Editor). (1994). *Marine Mammals and the Exxon Valdez.* Academic Press, San Diego.

Loughlin, T. R., & Perez, M. A. (1985). Mesoplodon stejnegeri. In *Mammalian Species* (Vol. 250, pp. 1-6): The American Society of Mammologists.

Loughlin, T. R., Perlov, A. S., & Vladimirov, V. A. (1992). Range-Wide Survey and Estimation of Total Number of Steller Sea Lions in 1989. *8*(3), 220-239.

Loughlin, T. R., Rugh, D. J., & Fiscus, C. H. (1984). Northern sea lion distribution and abundance: 1956-80. *48*(3), 729-740.

Loughlin, T. R., & York, A. E. (2000). An accounting of the sources of Steller sea lion, Eumetopias jubatus, mortality. *62*(4), 40-45.

Love, M. S., Yoklavich, M., & Thorsteinson, L. K. (2002). *The rockfishes of the northeast Pacific*: Univ of California Press.

Lovejoy, C., Massana, R., & Pedros-Alio, C. (2006). Diversity and Distribution of Marine Microbial Eukaryotes in the Arctic Ocean and Adjacent Seas. *Applied and Environmental Microbiology, 72*(5), 3085-3095. doi: 10.1128/AEM.72.5.3085–3095.2006.

Lovell, J. M., Findlay, M. M., Moate, R. M., & Yan, H. Y. (2005). The hearing abilities of the prawn *Palaemon serratus*. *Comparative Biochemistry and Physiology, 140*, 89-100.

Lovell, J. M., Findlay, M. M., Nedwell, J. R., & Pegg, M. A. (2006). The hearing abilities of the silver carp (*Hypopthalmichthys molitrix*) and bighead carp (*Aristichthys nobilis*). *Comparative Biochemistry and Physiology, Part A, 143*, 286-291.

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

Lowry, L. F., Nelson, R. R., & Frost, K. J. (1987). Observations of killer whales, Orcinus orca, in western Alaska: sightings, strandings, and predation on other marine mammals. *Canadian Field Naturalist, 101*, 6-12.

Lowry, L. F., Sheffield, G., & George, J. C. (2004). Bowhead whale feeding in the Alaskan Beaufort Sea, based on stomach contents analyses. *Journal of Cetacean Research and Management, 6*(3), 215-223.

Lucke, K., Siebert, U., Lepper, P. A., & Blanchet, M.-A. (2009). Temporary shift in masked hearing thresholds in a harbor porpoise (Phocoena phocoena) after exposure to seismic airgun stimuli. *Journal of the Acoustical Society of America, 125*(6), 4060-4070.

Lumsden, S. E., Hourigan, T. F., Bruckner, A. W., & Dorr, G. (2007). *The state of deep coral ecosystems of the United States: 2007*. (NOAA Technical Memorandum CRCP-3). Silver Spring, MD: National Oceanic and Atmospheric Administration (NOAA). p. 365.

Lunn, N., Atkinson, S., Branigan, M., Calvert, W., Clark, D., Doidge, B., . . . Otto, R. (2002). *Polar bear management in Canada 1997–2000.* Paper presented at the Polar bears: proceedings of the 13th working meeting of the IUCN/SSC Polar Bear Specialist Group, Nuuk, Greenland. IUCN, Gland, Switzerland ad Cambridge, UK. vii+ 153pp.

Luschi, P., Hays, G. C., & Papi, F. (2003). A Review of Long-Distance Movements by Marine Turtles, and the Possible Role of Ocean Currents. *Oikos, 103*(2), 293-302.

Lusseau, D. (2003). Effects of tour boats on the behavior of bottle-nose dolphins: Using Markov chains to model anthropogenic impacts. *Conservation Biology, 17*, 1785-1793.

Lusseau, D. (2006). The short-term behavioral reactions of bottlenose dolphins to interactions with boats in Doubtful Sound, New Zealand. *Marine Mammal Science, 22*(4), 802-818.

Luz, G. A. (1983). *Data Base for Assessing the Annoyance of the Noise of Small Arms*. Aberdeen Proving Ground, MD: United States Army Environmental Hygiene Agency. p. 15.

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., & Smith, T. G. (1989). Avian predation on ringed seal Phoca hispida pups. *Polar Biology, 9*(8), 489-490.

Lynghammar, A., Christiansen, J. S., Mecklenburg, C. W., Karamushko, O. V., Møller, P. R., & Gallucci, V. F. (2013). Species richness and distribution of chondrichthyan fishes in the Arctic Ocean and adjacent seas. *Biodiversity, 14*(1), 57-66.

MacDonald, I. R., Bluhm, B. A., Iken, K., Gagaev, S., & Strong, S. (2010). Benthic macrofauna and megafauna assemblages in the Arctic deep-sea Canada Basin. *Deep-Sea Research II, 57*, 136-152.

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. *36*, 1161-1173.

Mackintosh, N. (1966). The distribution of southern blue and fin whales. *Whales, dolphins, and porpoises*, 125-144.

Mackintosh, N. A. (1942). The natural history of whales. *Polar Record, 3*(24), 553-563.

MacLeod, C. D., & D'Amico, A. (2006). A review of beaked whale behaviour and ecology in relation to assessing and mitigating impacts of anthropogenic noise. . *Journal of Cetacean Research and Management, 7*(3).

MacLeod, C. D., Perrin, W. F., Pitman, R., Barlow, J., Balance, L., D'Amico, A., . . . Waring, G. T. (2006). Known and inferred distributions of beaked whale species (Cetacea: Ziphiidae). *Journal of Cetacean Research and Management, 7*, 271-480.

Magalhães, S., Prieto, R., Silva, M. A., Gonçalves, J. M., Afonso-Dias, M., & Santos, R. S. (2002). Short-Term Reactions of Sperm Whales (*Physeter macrocephalus*) to Whale-Watching Vessels in the Azores. *Aquatic Mammals, 28*(3), 267-274.

Malme, C. I., Miles, P. R., Clark, C. W., Tyack, P. L., & Bird, J. E. (1983). *Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior*. Cambridge, MA: U.S. Minerals Management Service.

Malme, C. I., Miles, P. R., Clark, C. W., Tyack, P. L., & Bird, J. E. (1984). *Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior/Phase II: January 1984 migration*. Cambridge, MA: U.S. Minerals Management Service.

Mangels, K. F., & Gerrodette, T. (1994). *Report of Cetacean Sightings During a Marine Mammal Survey in the Eastern Pacific Ocean and the Gulf of California Aboard the NOAA Ships McArthur and David Starr Jordan, July 28-November 6, 1993*: US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service [Southwest Fisheries Science Center].

Mann, D. A., Lu, Z., Hastings, M. C., & Popper, A. N. (1998). Detection of Ultrasonic Tones and Simulated Dolphin Echolocation Clicks by a Teleost Fish, the American Shad (Alosa sapidissima). *Journal of the Acoustical Society of America, 104*(1), 562-568.

Mann, D. A., & Popper, A. N. (1997). A clupeid fish can detect ultrasound. *Nature, 389*(6649), p. 341.

Mann, D. A., Popper, A. N., & Wilson, B. (2005). Pacific herring hearing does not include ultrasound. *Biology Letters, 1*(2), 158-161.

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

Marine Biological Consultants. (1987). *Ecology of Important Fisheries Species offshore California. OCS Study MMS 86-0093*. Camarillo, CA: Minerals Management Service.

Marquette, W. M., & Bockstoce, J. R. (1980). Historical shore-based catch of bowhead whales in the Bering, Chukchi, and Beaufort seas. *Marine Fisheries Review, 42*(9-10), 5-19.

Marret, F., & Zonneveld, K. A. F. (2003). Atlas of modern organic-walled dinoflagellate cyst distribution. *Review of Palaeobotany and Palynology, 125*(1-2), 1-200.

Martin Associates. (2014.). *The Economic Impact Of Marine Cargo At The Ports Of Tacoma And Seattle.* Lancaster, PA.

Martin, P. D., Douglas, D. C., Obritschkewitsch, T., & Torrence, S. (2015). Distribution and movements of Alaska-breeding Steller's Eiders in the nonbreeding period. *The Condor, 117*(3), 341-353. doi: 10.1650/CONDOR-14-165.1.

Masaki, Y. (1977). The separation of the stock units of sei whales in the North Pacific. *Rep. Int. Whal. Comm.(Special Issue), 1*, 71-77.

Mate, B. R., Bradford, A. L., Tsidulko, G., Vertyankin, V., & Ilyashenko, V. (2011). *Late-feeding season movements of a western North Pacific gray whale off Sakhalin Island, Russia and subsequent migration into the Eastern North Pacific*. (Paper SC/63/BRG23 presented to the IWC Scientific Committee).

Mate, B. R., Ilyashenko, V. Y., Bradford, A. L., Vertyankin, V. V., Tsidulko, G. A., Rozhnov, V. V., & Irvine, L. M. (2015). Critically endangered western gray whales migrate to the eastern

North Pacific. *Biology Letters, 11:20150071*. doi: http://dx.doi.org/10.1098/rsbl.2015.0071.

Mate, B. R., Lagerquist, B. A., & Calambokidis, J. (1999). *The Movements of North Pacific Blue Whales During the Feeding Season off Southern California and their Southern Fall Migration*. Newport, OR: Department of Fisheries and Wildlife.

Mathis, J. (2011). *Biogeochemical Assessment of the OCS Arctic Waters: Current Status and Vulnerability to Climate Change. Ongoing study, focus shifted from North Aleutian Basin to Chukchi Sea.*: Bureau of Ocean Energy Management, Regulation, and Enforcement. .

Matkin, C. O., & Saulitis, E. (1994). *Killer whale (Orcinus orca): Biology and management in Alaska*: Marine Mammal Commission.

Matthews, L. (1938). The humpback whales. *Megaptera nodosa*.

Maxwell, B. (1997). *Responding to Global Climate Change in Canada's Arctic. Vol. II of the Canada Country Study: Climate Impacts and Adaptations*: Environment Canada.

McCauley, R. D., Fewtrell, J., Duncan, A. J., Jenner, C., Jenner, M. N., Penrose, J. D., . . . McCabe, K. A. (2000). Marine Seismic Surveys-A Study of Environmental Implications. *Appea Journal*, 692-708.

McCauley, R. D., Fewtrell, J., & Popper, A. N. (2003). High intensity anthropogenic sound damages fish ears. *The Journal of the Acoustical Society of America, 113*(1), 638-642.

McDonald, M. A., Hildebrand, J. A., & Webb, S. C. (1995). Blue and fin whales observed on a seafloor array in the northeast Pacific. *Journal of the Acoustical Society of America, 98*(2), 712-721.

McDonald, M. A., Hildebrand, J. A., & Wiggins, S. M. (2006). Increases in deep ocean ambient noise in the Northeast Pacific west of San Nicolas Island, California. *Journal of the Acoustical Society of America, 120*(2), 711-718.

McDowell Group. (2015). *The Economic Value of Alaska's Seafood Industry*. Prepared for the Alaska Seafood Marketing Institute.

McEwan, D., & Jackson, T. A. (1996). *Steelhead Restoration and Management Plan for California*. Sacramento, CA: California Department of Fish and Game. p. 234.

McKinnon, L., Smith, P. A., Nol, E., Martin, J. L., Doyle, F. I., Abraham, K. F., . . . Bêty, J. (2010). Lower Predation Risk for Migratory Birds at High Latitudes. [10.1126/science.1183010]. *Science, 327*(5963), 326.

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.

Mecklenburg, C. W., Byrkjedal, I., Christiansen, J. S., Karamushko, O. V., Lynghammar, A., & Moller, P. R. (2013). List of marine fishes of the Arctic Region annotated with common names and zoogeographic characterizations. In (pp. 35). Akureyri, Iceland: Conservation of Arctic Flora and Fauna (CAFF).

Mecklenburg, C. W., Møller, P. R., & Steinke, D. (2011). Biodiversity of arctic marine fishes: taxonomy and zoogeography. *Marine Biodiversity, 41*(1), 109-140.

Meier, W. (2012). Are icebreakers changing the climate? *Icelights: Your Burning Questions About Ice and Climate* Retrieved

Mellinger, D. K., Stafford, K. M., & Fox, C. G. (2004). Seasonal occurrence of sperm whale (Physeter macrocephalus) sounds in the Gulf of Alaska, 1999-2001. *Marine Mammal Science, 20*(1), 48-62.

Melnikov, V., Zelensky, M., & Ainana, L. (2000). Humpback whales in the waters off Chukotka Peninsula. *Oceanology, 6*, 895-900.

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

Melvin, E. F., Parrish, J. K., & Conquest, L. L. (1999). Novel tools to reduce seabird bycatch in coastal gillnet fisheries. *Conservation Biology, 13*(6), 1386-1397.

Menard, J., Soong, J., Kent, S., Harlan, L., & Leon, J. (2017). *2015 Annual Management Report Norton Sound, Port Clarence, and Arctic, Kotzebue Areas*. (Fishery Management Report No. 17-15). Anchorage, Alaska: Alaska Department of Fish and Game p. 230.

Merchant, N. D., Pirotta, E., Barton, T. R., & Thompson, P. M. (2014). Monitoring Ship Noise to Assess the Impact of Coastal Developments on Marine Mammals. *Marine Pollution Bulletin, 78*, 85-95.

Merkel, F. R. (2010). *Light-induced bird strikes on vessels in Southwest Greenland*. Greenland Institute of Natural Resources. p. 26.

Mervis, J. (2011). NSF Leases Russian Icebreaker for Antarctic Resupply. Retrieved from http://www.sciencemag.org/news/2011/08/nsf-leases-russian-icebreaker-antarctic-resupply as accessed on 15 May 2017.

Michel, C., Nielsen, T. G., Nozais, C., & Gosselin, M. (2002). Significance of sedimentation and grazing by ice micro-and meiofauna for carbon cycling in annual sea ice (northern Baffin Bay). *Aquatic Microbial Ecology, 30*(1), 57-68.

Miksis-Olds, J. L., Bradley, D. L., & Niu, X. M. (2013). Decadal trends in Indian Ocean ambient sound. *Journal of the Acoustical Society of America, 134*, 3464-3475.

Miller, C. A., Reeb, D., Best, P. B., Knowlton, A. R., Brown, M. W., & Moore, M. J. (2011). Blubber thickness in right whales Eubalaena glacialis and Eubalaena australis related with reproduction, life history status and prey abundance. *Marine Ecology Progress Series, 438*, 267-283.

Miller, J. A., & Simenstad, C. A. (1997). A comparative assessment of a natural and created estuarine slough as rearing habitat for juvenile chinook and coho salmon. *Estuaries, 20*(4), 792-806.

Miller, P. J. O., Johnson, M. P., Madsen, P. T., Biassoni, N., Quero, M., & Tyack, P. L. (2009). Using at-sea experiments to study the effects of airguns on the foraging behavior of sperm whales in the Gulf of Mexico. *Deep-Sea Research I, 56*, 1168-1181.

Miller, S. L., Raphael, M. G., Falxa, G. A., Strong, C., Baldwin, J., Bloxton, T., . . . Young, R. D. (2012). Recent population decline of the marbled murrelet in the Pacific Northwest. *The Condor, 114*(4), 771-781.

Minerals Management Service. (2006). *Biological Evaluation of Steller 's Eider (Polysticta stelleri), Spectacled Eider(Somateria jischeri), and Kittlitz's Murrelet (Brachyramphus brevirostris) for Seismic Surveys in the Northeast Chukchi Sea and western Beaufort Sea Planning Areas*.

Misund, O. A. (1997). Underwater acoustics in marine fisheries and fisheries research. *Reviews in Fish Biology and Fisheries, 7*(1), 1-34.

Miyashita, T., Kato, H., & Kasuya, T. (1995). *Worldwide map of cetacean distribution based on Japanese sighting data*. Shimizu, Shizuoka, Japan: National Research Institute of Far Seas Fisheries.

Miyashita, T., Kishiro, T., Higashi, N., Sato, F., Mori, K., & Kato, H. (1996). Winter distribution of cetaceans in the western North Pacific inferred from sighting cruises 1993-1995. *REPORT-INTERNATIONAL WHALING COMMISSION, 46*, 437-442.

Mizroch, S. A., & Rice, D. W. (2006). Have North Pacific killer whales switched prey species in response to depletion of the great whale populations? *Marine Ecology Progress Series, 310*, 235-246.

Mizroch, S. A., & Rice, D. W. (2013). Ocean nomads: Distribution and movements of sperm whales in the North Pacific shown by whaling data and Discovery marks. *Marine Mammal Science, 29*(2), E136-E165.

Mizroch, S. A., Rice, D. W., & Breiwick, J. M. (1984). The sei whale, Balaenoptera borealis. *Marine Fisheries Review, 46*(4), 25-29.

Mocklin, J., George, J., Ferguson, M., Brattström, L., Beaver, V., Rone, B., . . . Accardo, C. (2012). Aerial photography of bowhead whales near Barrow, Alaska, during the 2011 spring migration. *IWC, 64*.

Molenaar, E. J., & Corell, R. (2009). *Arctic Shipping*. Berlin: Ecologic Institute. p. 33 p.

Monnahan, C. (2014). *Population Trends of the Eastern North Pacific Blue Whale.*

Monnahan, C. C., Branch, T. A., & Punt, A. E. (2015). Do ship strikes threaten the recovery of endangered eastern North Pacific blue whales? *, 31*(1), 279-297.

Monnahan, C. C., Branch, T. A., Stafford, K. M., Ivashchenko, Y. V., & Oleson, E. M. (2014). Estimating Historical Eastern North Pacific Blue Whale Catches Using Spatial Calling Patterns. *PLoS ONE, 9*(6), e98974. doi: 10.1371/journal.pone.0098974.

Montgomery, J. C., Jeffs, A., Simpson, S. D., Meekan, M., & Tindle, C. (2006). Sound as an orientation cue for the pelagic larvae of reef fishes and decapod crustaceans. *Advances in Marine Biology, 51*, 143-196.

Mooney, T. A., Hanlon, R. T., Christensen-Dalsgaard, J., Madsen, P. T., Ketten, D. R., & Nachtigall, P. E. (2010). Sound detection by the longfin squid (Loligo pealeii) studied with auditory evoked potentials: sensitivity to low-frequency particle motion and not pressure. *Journal of Experimental Biology, 213*, 3748-3759.

Mooney, T. A., Nachtigall, P. E., Breese, M., Vlachos, S., Whitlow, W., & Au, W. W. L. (2009). Predicting temporary threshold shifts in a bottlenose dolphin (*Tursiops truncatus*): The effects of noise level and duration. *Journal of Acoustical Society of America, 125*(3), 1816-1826.

Mooney, T. A., Nachtigall, P. E., Castellote, M., Taylor, K. A., Pacini, A. F., & Esteban, J. A. (2008). Hearing pathways and directional sensitivity of the beluga whale (*Delphinapterus leucas*). *Journal of Experimental Biology, 362*(2), 108-116.

Mooney, T. A., Yamato, M., & Branstetter, B. K. (2012). Hearing in cetaceans: from natural history to experimental biology. *Advances in Marine Biology, 63*, 197-246.

Moore, J. E., & Barlow, J. (2011). Bayesian state-space model of fin whale abundance trends from a 1991–2008 time series of line-transect surveys in the California Current. *Journal of Applied Ecology, 48*(5), 1195-1205.

Moore, J. E., & Barlow, J. P. (2014). Improved abundance and trend estimates for sperm whales in the eastern North Pacific from Bayesian hierarchical modeling. *Endangered Species Research, 25*(2), 141-150.

Moore, J. E., & Weller, D. W. (2013). *Probability of taking a western North Pacific gray whale during the proposed Makah hunt*. La Jolla, CA: NOAA Tech Memo, NMFS-SWFSC-506. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Moore, P. W. B., & Schusterman, R. J. (1987). Audiometric Assessment of Northern Fur Seals, Callorhinus ursinus. *Marine Mammal Science, 3*(1), 31-53.

Moore, S., Waite, J., Friday, N., & Honkalehto, T. (2002). Cetacean distribution and relative abundance on the central–eastern and the southeastern Bering Sea shelf with reference to oceanographic domains. *Progress in oceanography, 55*(1), 249-261.

Moore, S. E., & Reeves, R. R. (1993). Distribution and movement. In. Burns, J. J., Montague, J. J. & Cowles, C. J. (Eds.), *The Bowhead Whale* (Vol. 2, pp. 313-386). Lawrence, KS: Society for Marine Mammology.

Moore, S. E., Waite, J. M., Mazzuca, L. L., & Hobbs, R. C. (2000). Mysticete whale abundance and observations on prey association on the central Bering Sea shelf. *Journal of Cetacean Research and Management, 2*(3), 227-234.

Mordy, C. W., Devol, A., Eisner, L. B., Kachel, N., Ladd, C., Lomas, M. W., . . . Stabeno, P. J. (2017). Nutrient and phytoplankton dynamics on the inner shelf of the eastern Bering Sea. *Journal of Geophysical Research: Oceans*.

Moreland, E., Cameron, M., & Boveng, P. (2013). Bering Okhotsk Seal Surveys (BOSS), joint US-Russian aerial surveys for ice-associated seals, 2012-13. *Alaska Fisheries Science Center Quarterly Report July*, 1-6.

Morgan, L. E., Etnoyer, P., Scholz, A. J., Mertens, M., & Powell, M. (2005). *Conservation and management implications of deep-sea coral and fishing effort distributions in the northeast Pacific Ocean*. New York, NY: Springer-Verlag.

Morisaka, T., Shinohara, M., Nakahara, F., & Akamatsu, T. (2005). Geographic variations in the whistles among three Indo-Pacific bottlenose dolphin Tursiops aduncus populations in Japan. *Fisheries Science, 71*(3), 568-576.

Mosbech, A., R. S. Danø, F. Merkel, C. Sonne, G. Gilchrist, & Flagstad, A. (2006). Use of satellite telemetry to locate key habitats for King Eiders Somateria spectabilis in West Greenland. In *Waterbirds around the World* (pp. 769–776.). Stationery Office, Edinburgh, UK.

Moser, M. L., & Lee, D. S. (1992). A fourteen-year survey of plastic ingestion by western North Atlantic seabirds. *Colonial Waterbirds, 15*(1), 83-94.

Mueter, F. J. (2004). Gulf of Alaska. In *Marine Ecosystems of the North Pacific* (pp. 153-175): North Pacific Marine Science Organization.

Mullin, K., Hoggard, W., Roden, C., Lohoefener, R., Rogers, C., & Taggart, B. (1991). *Cetaceans on the upper continental slope in the north-central Gulf of Mexico*. Pascagoula, MS: U.S. Minerals Management Service.

Mulsow, J., Finneran, J. J., & Houser, D. S. (2011). California sea lion (Zalophus californianus) aerial hearing sensitivity measured using auditory steady-state response and psychophysical methods. . *The Journal of the Acoustical Society of America, 129*(4), 2298-2306.

Munger, L. M., Wiggins, S. M., Moore, S. E., & Hildebrand, J. A. (2008). North Pacific right whale (Eubalaena japonica) seasonal and diel calling patterns from long-term acoustic

recordings in the southeastern Bering Sea, 2000–2006. *Marine Mammal Science, 24*(4), 795-814.
Murie, O. J. (1959). Fauna of the Aleutian Islands and Alaska peninsula. *North American Fauna*, 1-364.
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., Angliss, R. P., Allen, B. A., Boveng, P. L., Breiwick, J. M., . . . Zerbini, A. N. (2017). *Alaska Marine Mammal Stock Assessments, 2016*. Seattle, WA: U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service, Alaska Fisheries Science Center. p. 375.
Nachtigall, P. E., Supin, A. Y., Amundin, M., Roken, B., Moller, T., Mooney, T. A., . . . Yuen, M. M. L. (2007). Polar bear Ursus maritimus hearing measured with auditory evoked potentials. *Journal of Experimental Biology, 210*(7), 1116-1122.
Nachtigall, P. E., Supin, A. Y., Pawloski, J., & Au, W. W. L. (2004). Temporary threshold shifts in recovery following noise exposure in the Atlantic bottlnosed dolphin (*Tursiops truncatus*) measured using evoked auditory potentials. *Marine Mammal Science, 20*(4), 673-687.
Nachtigall, P. E., Yuen, M. M. L., Mooney, T. A., & Taylor, K. A. (2005). Hearing measurements from a stranded infant Risso's dolphin, Grampus griseus. *Journal of Experimental Biology, 208*(21), 4181-4188.
NANA Regional Corporation, I. (2016). Kivalina. *Our Region: Village Profile* Retrieved
Napp, J. M., & Hunt, G. L. (2001). Anomalous conditions in the south-eastern Bering Sea 1997: linkages among climate, weather, ocean, and Biology. *Fisheries Oceanography, 10*(1), 61-68.
Nasu, K. (1966). Fishery oceanographic study on the baleen whaling grounds. *Scientific Reports of the Whales Research Institute Tokyo, 20*, 157-210.
Nasu, K. (1974). *Movement of baleen whales in relation to hydrographic conditions in the northern part of the North Pacific Ocean and the Bering Sea.* Paper presented at the International Symposium for Bering Sea Study, Hakodate, Japan.
National Academies Press. (2007). *Polar Icebreakers in a Changing World: An Assessment of U.S. Needs. Chapter 8: Analysis of Alternatives for USAP Resupply.* Washington, DC.
National Academy of Engineers (NAE) and National Research Council (NRC). (2012). *Macondo well, Deepwater Horizon blowout: Lessons for Improving Offshore Drilling Safety*. The National Academies Press, Washington, D.C. 196 pp.
National Institute for Occupational Safety and Health (NIOSH). (1998). *Criteria for a recommended standard: Occupational noise exposure*. Cincinnati, Ohio: United States Department of Health and Human Services.
National Marine Fisheries Service. (2013). *Final recovery plan for the North Pacific right whale (Eubalaena japonica)*. Silver Spring, MD: National Marine Fisheries Service, Office of Protected Resources.
National Marine Fisheries Service. (2014a). Chinook Salmon (*Oncorhynchus tshawytscha*) Retrieved from http://www.nmfs.noaa.gov/pr/species/fish/cohosalmon.htm as accessed on 09 September 2014.

National Marine Fisheries Service. (2014b). Office of Protected Resources, Oil & Gas: Incidental Take Authorizations Retrieved from http://www.nmfs.noaa.gov/pr/permits/incidental/oilgas.htm#bp_northstar2019 as accessed on 27 February 2017.

National Marine Fisheries Service. (2014c). Steelhead Trout (*Oncorhynchus mykiss*) Retrieved from http://www.nmfs.noaa.gov/pr/species/fish/steelheadtrout.htm as accessed on 09 September 2014.

National Marine Fisheries Service. (2015). Bocaccio (Sebastes paucispinus) Retrieved from http://www.fisheries.noaa.gov/pr/species/fish/bocaccio.html as accessed on 1/16.

National Marine Fisheries Service. (2016a, 10 February 2016). Leatherback Turtle (Dermochelys coriacea) Retrieved Retrieved 10 February 2016from http://www.nmfs.noaa.gov/pr/species/turtles/leatherback.html as accessed on 10 May.

National Marine Fisheries Service. (2016b). Sockeye Salmon (*Oncorhynchus nerka*) Retrieved from http://www.fisheries.noaa.gov/pr/species/fish/sockeye-salmon.html as accessed on 04 March 2016.

National Marine Fisheries Service. (2016c). *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts*. U.S. Department of Commerce, NOAA. p. 178.

National Marine Fisheries Service. (2017a). Annual Landings by Species for Alaska. Retrieved from https://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/annual-landings-with-group-subtotals/index as accessed on 12 May 2017.

National Marine Fisheries Service. (2017b). *Fisheries Economics of the United States, 2015*. U.S. Department of Commerce. p. 247.

National Marine Fisheries Service. (2017c). Large Whale Entanglements - The Marine Debris Threat Retrieved from https://alaskafisheries.noaa.gov/pr/entanglement-whales as accessed on 01 March 2017.

National Marine Fisheries Service. (2017d). Pinniped Entanglement in Marine Debris-The Marine Debris Threat Retrieved from https://alaskafisheries.noaa.gov/pr/pinniped-entanglement as accessed on 01 March 2017.

National Marine Fisheries Service. (2017e, 11/1/2007). Pinto Abalone Retrieved Retrieved 11/1/2007from http://www.westcoast.fisheries.noaa.gov/protected_species/abalone/Pinto_abalone.html as accessed on 2/28.2017.

National Marine Fisheries Service. (2018). *2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. Silver Spring, MD: U.S. Department of Commerce, NOAA. p. 167.

National Oceanic and Atmospheric Administration (Cartographer). (2006). Beaufort Sea: Point Barrow to Herschel Island [Mercator Projection].

National Oceanic and Atmospheric Administration (Cartographer). (2008). Alaska: Arctic Coast [Mercator Projection].

National Oceanic and Atmospheric Administration. (2011). How do Fish Swim? How Fast? Retrieved from http://www.nefsc.noaa.gov/faq/fishfaq1b.html as accessed on 28 May 2015.

National Oceanic and Atmospheric Administration. (2014). Pacific Eulachon (*Thaleichthys pacificus*) Retrieved from http://www.nmfs.noaa.gov/pr/species/fish/pacificeulachon.htm as accessed on 15 September 2014.

National Oceanic and Atmospheric Administration (NOAA) (Cartographer). (2004). North Pacific Ocean: Bering Sea (Southern Part) [Mercator Projection].

National Oceanic and Atmospheric Administration (NOAA) Fisheries-Alaska Regional Office. (2017a). Co-Management of Marine Mammals website Retrieved from https://alaskafisheries.noaa.gov/pr/comanagement as accessed on 24 February 2017.

National Oceanic and Atmospheric Administration (NOAA) FISheries-Alaska Regional Office. (2017b). Large Whale Entanglements Retrieved from https://alaskafisheries.noaa.gov/pr/entanglement-whales as accessed on 24 February 2017.

National Oceanic and Atmospheric Administration (NOAA) Fisheries-Alaska Regional Office. (2017c). Subsistence Halibut Fishing in Alaska Retrieved from https://alaskafisheries.noaa.gov/fisheries/subsistence-halibut as accessed on 28 February 2017.

National Park Service. (2016). Annual Park Recreation Visitation (1904 - Last Calendar Year) (report generated for Olympic National Park). Retrieved from https://irma.nps.gov/Stats/SSRSReports/Park%20Specific%20Reports/Annual%20Park%20Recreation%20Visitation%20(1904%20-%20Last%20Calendar%20Year) as accessed on 12 May 2017.

National Science Foundation (NSF) United States Antarctic Program (USAP). (2017). U.S. Antarctic Program Retrieved from https://www.usap.gov/aboutUSAPParticipants/ as accessed on 06 March 2017.

National Snow and Ice Data Center. (2017a). 2017 ushers in record low extent. *NSIDC Sea Ice News and Analysis* Retrieved from https://nsidc.org/arcticseaicenews/2017/02/2017-ushers-in-record-low-extent/ as accessed on 07 February 2017.

National Snow and Ice Data Center. (2017b). Arctic Sea Ice News and Analysis Retrieved from https://nsidc.org/arcticseaicenews/

NatureServe. (2004). *Phoebastria albatrus - (Pallas, 1769): Short-tailed albatross*. NatureServe.

Neilson, J. L. (2006). *Humpback whale (Megaptera novaeangliae) entanglement in fishing gear in northern southeastern Alaska.* Master of Science, University of Alaska, Fairbanks, Unpublished.

Neilson, J. L., Gabriele, C. M., Jensen, A. S., Jackson, K., & Straley, J. M. (2012). Summary of reported whale-vessel collisions in Alaskan waters. *Journal of Marine Biology, 2012*, 106282. doi: 10.1155/2012/106282.

Nelson, K. S. (1997). Marbled murrelet (*Brachyramphus marmoratus*). *The Birds of North America*.

Nelson, R. K. (1981). *Harvest of the sea: coastal subsistence in modern Wainwright*. North Slope Borough, Barrow, Alaska. p. 125.

Nelson, R. R., Burns, J. J., & Frost, K. J. (1984). The bearded seal (Erignathus barbatus). *7*, 1-6.
Nemoto, T. (1957). Foods of baleen whales in the northern Pacific. *Sci. Rep. Whales Res. Inst. Tokyo, 12*, 33-89.
Nemoto, T. (1959). Food of baleen whales with reference to whale movements. *Sci. Rep. Whales Res. Inst, 14*, 149-290.
Nemoto, T., & Kawamura, A. (1977). Characteristics of food habits and distribution of baleen whales with special reference to the abundance of North Pacific sei and Bryde's whales. *Reports of the International Whaling Commission, Special, 1*, 80-87.
New, L. F., Hall, A. J., Harcourt, R., Kaufman, G., Parsons, E. C. M., Pearson, H. C., . . . Schick, R. S. (2015). The modelling and assessment of whale-watching impacts. *Ocean and Coastal Management, 115*, 10-16.
Nichols, T. K. (1999). Development of a ringed seal (Phoca hispida) habitat suitability index for the Canadian High Arctic using synthetic aperture radar.
Nishiwaki, M., & Handa, C. (1958). Killer whales caught in the coastal waters off Japan for recent 10 years. *Scientific Reports of the Whales Research Institute, 13*, 85-96.
NMFS. (1991). *Recovery Plan for the Humpback Whale (Megaptera novaeangliae)*. Silver Spring, MD: National Marine Fisheries Service.
NMFS. (1992). *Recovery Plan for Steller Sea Lions (Eumetopias jubatus)*. Silver Spring, MD.
NMFS. (1997). Endangered and Threatened Species: Listing of Several Evolutionary Significant Unites (ESUs) of West Coast Steelhead. *Federal Register, 62*(159), 43937-43953.
NMFS. (1998). *Recovery Plan For The Blue Whale (Balaenoptera Musculus)*. Silver Spring, MD. p. 42.
NMFS. (2006). *Recovery Plan for the Puget Sound Chinook Salmon (Oncorhynchus tshawytscha)*. Seattle, WA: National Marine Fisheries Service.
NMFS. (2007a). *Southern Right Whale 5-Year Review: Summary and Evaluation*. Silver Spring, MD: NMFS.
NMFS. (2007b). *Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan*. Portland, OR: National Marine Fisheries Service.
NMFS. (2008a). *Recovery Plan for Southern Resident Killer Whales (Orcinus orca)*. Seattle, WA: National Marine Fisheries Service.
NMFS. (2008b). *Recovery Plan For The Steller Sea Lion Eastern And Western Distinct Population Segments (Eumetopias jubatus) Revision*. Silver Spring, MD.
NMFS. (2009a). *Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan*. Portland, OR: National Marine Fisheries Service.
NMFS. (2009b). *Recovery Plan For Lake Ozette Sockeye Salmon (Oncorhynchus nerka)*. Portland, OR: National Marine Fisheries Service.
NMFS. (2010a). *Final Recovery Plan for the Fin Whale (Balaenaptera physalus)*. Silver Spring, MD: National Marine Fisheries Service.
NMFS. (2010b). *Final Recovery Plan for the sperm whale (Physeter macrocephalus)*. Silver Spring, MD.
NMFS. (2011a). *Recovery Plan for the Sei Whale (Balaenoptera borealis)*. Silver Spring, MD: National Marine Fisheries Service.
NMFS. (2011b). *Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead*. Portland, OR: National Marine Fisheries Service.

NMFS. (2012a). *Environmental Assessment for Issuance of IHAs for Shell Beaufort and Chukchi Sea Oil Exploration Plans, May 2012*.

NMFS. (2012b). *Final Recovery Plan for Central California Coast coho salmon Evolutionarily Significant Unit*. Santa Rosa, CA: National Marine Fisheries Service.

NMFS. (2012c). *Final Rule to Revise the Critical Habitat Designation for Leatherback Sea Turtles*. Southwest Fisheries Science Center.

NMFS. (2012d). *Southern California Steelhead Recovery Plan*. Long Beach, CA: National Marine Fisheries Service.

NMFS. (2013a). *ESA Recovery Plan for Lower Columbia River Coho Salmon, Lower Columbia River Chinook Salmon, Columbia River Chum Salmon, and Lower Columbia River Steelhead*. Portland, OR: Naitonal Marine Fisheries Service.

NMFS. (2013b). *Occurrence of western distinct population segment Steller sea lions East of 144^0 W. longitude*.

NMFS. (2013c). *South-Central California Coast Steelhead Recovery Plan*. Long Beach, CA: National Marine Fisheries Service.

NMFS. (2014). *Final Recovery Plan for the Southern Oregon/Northern California Coast Evolutionarily Significant Unit of Coho Salmon (Oncorhynchus kisutch)*. Arcata, CA: National Marine Fisheries Service.

NMFS. (2015). *ESA Recovery Plan for Snake River Sockeye Salmon (Oncorhynchus nerka)*. Portland, OR: National Marine Fisheries Service.

NMFS. (2016a). *Public Draft Coastal Multispecies Recovery Plan*. Santa Rosa, CA: National Marine Fisheries Service.

NMFS. (2016b). *Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing: Underwater acoustic thresholds for onset of permanent and temporary threshold shifts*. (NOAA Technical Memorandum NMFS-OPR-55). U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. p. 178.

NMFS. (2017a). *Recovery Plan for the Southern Distinct Population Segment of Eulachon (Thaleichthys pacificus)*. Portland, OR: National Marine Fisheries Service.

NMFS. (2017b). *Rockfish Recovery Plan: Puget Sound / Georgia Basin yelloweye rockfish (Sebastes ruberrimus) and bocaccio (Sebastes paucispinis)*. Seattle, WA: National Marine Fisheries Service.

NMFS and USFWS. (1992). *Recovery Plan for Leatherback Turtles in the U.S. Caribbean, Atlantic and Gulf of Mexico*. (National Marine Fisheries Service (NMFS)). Washington, DC: National Marine Fisheries Service. p. 69.

NMFS and USFWS. (1998). *Recovery Plan for U.S. Pacific Populations of the Leatherback Turtle (Dermochelys coriacea)*. (National Marine Fisheries Service (NMFS)). Silver Spring, MD: National Marine Fisheries Service.

NOAA. (2005). *Final Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Region.

NOAA. (2014). *Report on the Entanglement of Marine Species in Marine Debris with an Emphasis on Species in the United States*. Silver Spring, MD: Marine Debris Program.

NOAA NMS. (2014a). *Socioeconomics of Washington's Outer Coast and Olympic Coast National Marine Sanctuary: Economic Contributions from Recreation*. Port Angeles, WA.

NOAA NMS. (2014b). *Socioeconomics of Washington's Outer Coast and Olympic Coast National Marine Sanctuary: Recreation Activities.* Port Angeles, WA.

Norcross, B. L., Holladay, B. A., & Mecklenburg, C. W. (2013). *Recent and historical distribution and ecology of demersal fishes in the Chukchi Sea planning area*. (OCS Study BOEM 2012-073). Fairbanks, AK: U.S. Department of the Interior, Bureau of Ocean Energy Management (BOEM), Outer Continental Shelf (OCS) Region, University of Alaska Fairbanks. p. 210.

Norris, K. S., & Prescott, J. H. (1961). Observations of Pacific cetaceans of Californian and Mexican waters. *University of California Publications in Zoology, 63*, 291-402.

Norwegian Polar Institute. Arctic tern (Sterna paradisaea). Retrieved from http://www.npolar.no/en/species/arctic-tern.html as accessed on 3/27/2017.

Nowacek, D. P., Johnson, M. P., & Tyack, P. L. (2004). North Atlantic right whales (Eubalaena glacialis) ignore ships but respond to alerting stimuli. *Proceedings of the Royal Society of London B: Biological Sciences, 271*(1536), 227-231.

Nowacek, D. P., Thorne, L. H., Johnston, D. W., & Tyack, P. L. (2007). Responses of Cetaceans to Anthropogenic Noise. *Mammal Review, 37*(2), 81-115.

NPFMC. (1990). *Fishery Management Plan for the Salmon Fisheries in the EEZ off the Coast of Alaska* Anchorage, Alaska: North Pacific Fishery Management Council.

NPFMC. (2005). *EFH Final Action North Pacific Fisheries Management Council, HAPC Final Council Motion*.

NPFMC. (2009). *Fishery Management Plan for Fish Resources of the Arctic Management Area*. Anchorage, Alaska. p. 146 p.

NPFMC. (2011). *Fishery Management Plan for Bering Sea/Aleutian Islands King and Tanner Crabs*. Anchorage, Alaska. p. 222 p.

NPFMC. (2012a). *Fishery management plan for the salmon fisheries in the EEZ off Alaska*. Anchorage, AK: North Pacific Fishery Management Council (NPFMC). p. 59.

NPFMC. (2012b). *Habitat Areas of Particular Concern (HAPC): Areas of Skate Concentration*. NMFS, Alaska Region. p. 174 p.

NPFMC. (2014). *Fishery Management Plan for the Scallop Fishery off Alaska*. Anchorage, Alaska. p. 80 p.

NPFMC. (2017). *Fishery Management Plan for Groundfish for the Bering Sea and Aleutian Islands Management Area*. Anchorage, Alaska. p. 147 p.

NRC. (2003). *Ocean Noise and Marine Mammals*. Washington, DC: National Academics Press. p. 203.

NRC. (2005). *Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects*. Washington, D.C.: The National Academies Press.

NSIDC. (2007). *National Snow and Ice Data Center World Data Center for Glaciology, Boulder Annual Report 2007*. Boulder, CO. p. 56.

Nuka Research and Planning Group, & Pearson Consulting. (2014). *Aleutian Island Risk Assessment Phase B: Final Program Report*. U.S. Committee on the Marine Transportation System.

Nuttall, M. (2005). *Encyclopedia of the Arctic*: Routledge.

O'Dor, R. K. (2003). *The unknown ocean: The baseline report of the census of Marine Life Research Program*. Consortium for Oceanographic Research and Education.

O'Hara, J., & Wilcox, J. R. (1990). Avoidance responses of loggerhead turtles, Caretta caretta, to low frequency sound. *Copeia, 1990*(2), 564-567.

Offutt, G. C. (1970). Acoustic Stimulus Perception by the American Lobster *Homarus americanus* (Decapoda). *Experientia, 26*, 1276-1278.

Ognev, S. I. (1935). Mammals of the U.S.S.R. and adjacent countries. *Isreal Program for Scientific Translations, Jerusalem (1962), III Carnivora (Fissipedia and Pinnipedia)*, 641.

Ohsumi, S., & Wada, S. (1974). Status of whale stocks in the North Pacific, 1972. *Reports of the International Whaling Commission, 24*, 114-126.

Okkonen, S. R., Ashjian, C. J., Campbell, R. G., Clarke, J. T., Moore, S. E., & Taylor, K. D. (2011). Satellite observations of circulation features associated with a bowhead whale feeding ‘hotspot’near Barrow, Alaska. *Remote Sensing of Environment, 115*(8), 2168-2174.

Olsen, E., Budgell, P., Head, E., & Oien, N. (2009). First Satellite-Tracked Long-Distance Movement of a Sei Whale (Balaenoptera borealis) in the North Atlantic. *Aquatic Mammals, 35*(3), 313-318. doi: 10.1578/AM.35.3.2009.313.

Olympic Coast National Marine Sanctuary. (2011). *Olympic Coast National Marine Sanctuary: Final Management Plan and Environmental Assessment.* Port Angeles, WA.

Omura, H. (1955). Whales in the northern part of the North Pacific. *Nor. Hvalfangst-tidende 44*(6), 323-345.

Omura, H. (1958). North Pacific right whale. *Scientific Reports of the Whales Research Institute, 13*, 1-52.

Omura, H. (1986). History of right whale catches in the waters around Japan. *Report of the International Whaling Commission, 10*(Special issue), 35-41.

Omura, H., Ichihara, T., & Kasuya, T. (1970). Osteology of pygmy blue whale with additional information on external and other characteristics. *Scientific Reports of the Whales Research Institute, 22*, 1-27.

Onley, D., & Scofield, P. (2007). *Albatrosses, Petrels and Shearwaters of the World*. Princeton, NJ: Princeton University Press.

Ostenso, N. A. (2014). Arctic Ocean: Topography of the ocean floor. In The Editors of Encyclopedia Britannica (Ed.), *Encyclopedia Britannica*. Retrieved from http://www.britannica.com/EBchecked/topic/33188/Arctic-Ocean/57837/Topography-of-the-ocean-floor#ref518833.

Overland, J., & Wang, M. (2013). When will the summer Arctic be nearly sea ice free? *Geophys. Res. Lett., 40*(10), 2097-2101.

Overland, J., Wang, M., & Walsh, J. (2010). Atmosphere. In. Richter-Menge, J. & Overland, J. E. (Eds.), *Arctic Report Card 2010* (pp. 8-15).

Ozanich, E., Gerstoft, P., Worcester, P. F., Dzieciuch, M. A., & Thode, A. (2017). Eastern Arctic ambient noise on a drifting vertical array. *The Journal of the Acoustical Society of America, 142*(4), 1997-2006. doi: https://doi.org/10.1121/1.5006053.

Pacific Gas & Electric (PG&E). (2011). *A Review of Effects of Seismic Testing on Marine Fish and Fisheries as Applied to the DCPP 3-D Seismic Project*. Prepared by: Tenera Environmental, San Luis Obispo, CA for Pacific Gas & Electric. 34 pp.

Palsson, W. A., Tsou, T.-S., Bargmann, G. G., Buckley, R. M., West, J. E., Mills, M. L., . . . Pacunski, R. E. (2009). *The biology and assessment of rockfishes in Puget Sound*: Washington Department of Fish and Wildlife, Fish Program, Fish Management.

Parkinson, C. L. (2014). Global Sea Ice Coverage from Satellite Data: Annual Cycle and 35-Year Trends. *Journal of Climate, 27*(24), 9377-9382. doi: 10.1175/JCLI-D-14-00605.1.

Parkinson, C. L., & Cavalieri, D. J. (2012). Antarctic Sea Ice Variability and Trends, 1979-2010. *The Cryosphere, 6*, 871-880. doi: 10.5194/tc-6-871-2012.

Parks, S. E., Clark, C. W., & Tyack, P. L. (2007). Short- and long-term changes in right whale calling behavior: The potential effects of noise on acoustic communication. *122*(6), 3725-3731.

Parks, S. E., Johnson, M., Nowacek, D., & Tyack, P. L. (2011). Individual Right Whales Call Louder in Increased Environmental Noise. *Biology Letters, 7*, 33-35.

Parsons, E. C. M. (2012). The negative impacts of whale-watching. *Journal of Marine Biology*, 1-9.

Patek, S. N., & Caldwell, R. L. (2006). The stomatopod rumble: Low frequency sound production in *Hemisquilla californiensis*. *Marine and Freshwater Behaviour and Physiology, 39*(2), 99-111.

Patenaude, N. J., Richardson, W. J., Smultea, M. A., Koski, W. R., Miller, G. W., Würsig, B., & Jr., C. R. G. (2002). Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the Alaskan Beaufort Sea. *Marine Mammal Science, 18*(2), 309-335.

Pater, L. L., & Shea, J. W. (1981). *Techniques for Reducing Gun Blast Noise Levels: An Experimental Study*. Silver Spring, MD: U.S. Navy.

Pauley, G. B., Bowers, K. L., & Thomas, G. L. (1988). *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific northwest) - Chum Salmon*. U.S. Fish and Wildlife Service Biolgoical Report 82 (11.81), U.S. Army Corps of Engineers TR EL 82-4.

Pauley, G. B., Risher, R., & Thomas, G. L. (1989). *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific northwest) - Sockeye Salmon*. U.S. Fish and Wildlife Service Biolgoical Report 82 (11.116), U.S. Army Corps of Engineers TR EL 82-4.

Payne, M. C., Brown, C. A., Reusser, D. A., Lee, H., & Álvarez, I. (2012). Ecoregional Analysis of Nearshore Sea-Surface Temperature in the North Pacific (SST Analysis of Nearshore North Pacific). *PLoS ONE, 7*(1 DOI - 10.1371/journal.pone.0030105), e30105.

Payne, R., Brazier, O., Dorsey, E. M., Perkins, J. S., Titus, V., & Titus, A. (1983). External Features in Southern Right Whale, Eubalaena australis, and Their Use in Identifying Individuals. In Payne, R. (Ed.), *Communication and Behavior of Whales* (pp. 371-445). Boulder, Colorado: Westview Press.

Pearce, J. M., Esler, D., & Degtyarev, A. G. (1998). Nesting ecology of spectacled eiders *Somateria fischeri* on the Indigirka River deltas, Russia. *Wildfowl, 49*, 110-123.

Pennycuick, C. J. (1982). The flight of petrels and albatrosses (Procellariiformes), observed in south Georgia and its vicinity. *Philosophical Transactions of the Royal Society of London, 300*(1098), 75-106.

Pepper, C. B., Nascarella, M. A., & Kendall, R. J. (2003). A review of the effects of aircraft noise on wildlife and humans, current control mechanisms, and the need for further study. *Environmental Management, 32*(4), 418-432. doi: 10.1007 /s00267 -003-3024-4.

Perovich, D., Meier, W., Tschudi, M., Farrell, S., Gerland, S., Hendricks, S., . . . Haas, C. (2016). *Sea Ice*.

Perrin, W. F., Mead, J. G., & Brownell Jr, R. L. (2009). Review of the evidence used in the description of currently recognized cetacean subspecies.

Perrin, W. F., & Wursig, B. (Eds.). (2009). *Encyclopedia of Marine Mammals*: Academic Press.

Perry, R. (2003). A Guide to the Marine Plankton of Southern California. Retrieved from UCLA Marine Science Center OceanGLOBE website:

Perry, S. L., DeMaster, D. P., & Silber, G. K. (1999). The great whales: History and status of six species listed as endangered under the US Endangered Species Act of 1973. *Marine Fisheries Review, 61*(1), 1-74.

Petersen, M. R. (1981). Populations, feeding ecology, and molt of Steller's eider. *Condor, 83*, 252-256.

Petersen, M. R., Douglas, D. C., & Mulcahy, D. M. (1995). Use of implanted satellite transmitters to locate spectacled eiders at-sea. *Condor, 97*, 276-278.

Petersen, M. R., Grand, J. B., & Dau, C. P. (2000). Spectacled Eider (*Somateria fischeri*). *The Birds of North America*.

Petersen, M. R., Larned, W. W., & Douglas, D. C. (1999). At-sea distribution of Spectacled Eiders: A 120-year-old mystery resolved. *The Auk, 116*(4), 1009-1020. doi: 10.2307/4089681.

Petersen, M. R., Piatt, J. F., & Trust, K. A. (1998). Food of spectacled eiders *Somateria fischeri* in the Bering Sea, Alaska. *Wildfowl, 49*, 124-128.

Peterson, C. H., Rice, S. D., Short, J. W., Esler, D., Bodkin, J. L., Ballachey, B. E., & Irons, D. B. (2003). Long-term ecosystem response to the Exxon Valdez oil spill. *Science, 302*, 2082-2086.

Peterson, W. T., & Keister, J. E. (2003). Interannual variability in copepod community composition at a coastal station in the northern California Current: a multivariate approach. *Deep Sea Research Part II: Topical Studies in Oceanography, 50*(14), 2499-2517.

PFMC. (2000). *Amendment 14 to the Pacific Coast Salmon Plan: Incorporating the Regulatory Impact Review/Initial Regulatory Flexibility Analysis and Final Supplemental Environmental Impact Statement*. Portland, Oregon: Pacific Fishery Management Council. p. 420.

PFMC. (2016a). *Coastal Pelagic Species Fishery Management Plan as Amended Through Amendment 15*. Portland, Oregon: Pacific Fishery Management Council. p. 49.

PFMC. (2016b). *Fishery Management Plan for U.S. West Coast Fisheries for Highly Migratory Species as Amended Through Amendment 3*. Portland, Oregon: Pacific Fishery Management Council. p. 120.

PFMC. (2016c). *Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery*. Portland, Oregon: Pacific Fishery Mangement Council.

Piatt, J. F., & Drew, G. S. (2015). North Pacific Pelagic Seabird Database 2.0: U.S. Geological Survey. Retrieved from https://alaska.usgs.gov/products/data.php?dataid=1.

Piatt, J. F., Lensink, C. J., Butler, W., & Kendziorek, M. (1990). Immediate impact of the 'Exxon Valdez' oil spill on marine birds. *The Auk, 107*(2), 387-397. doi: 10.2307/4087623.

Piatt, J. F., & Naslund, N. L. (1995). Abundance, distribution, and population status of marmbled murrelets in Alaska. In. Ralph Jr., C. L., Hunt, G. L., Raphael, M. G. & Piatt, J. F. (Eds.), *Ecology and conservation of the marbled murrelet* (pp. 285-294). Albany, CA: Forest Service General Technical Report PSW-152.

Piatt, J. F., Wetzel, J., Bell, K., DeGange, A. R., Balogh, G. R., Drew, G. S., & Bryrd, G. V. (2006). Predictable hotspots and foraging habitat of the endangered short-tailed albatross (*Phoebastria albatrus*). *Deep-Sea Research II, 53*(3-4), 387-398.

Piniak, W. E. D., Eckert, S. A., Mann, D. A., & Horrocks, J. (2012). *Amphibious hearing in hatchling hawksbill sea turtles (Eretmochelys imbircata).* Paper presented at the 31st Annual Symposium on Sea Turtle Biology and Conservation, San Diego, CA.

Pinkerton, M., Bradford-Grieve, J., & Hanchet, S. (2010). A balanced model of the food web of the Ross Sea, Antarctica. *CCAMLR Science, 17*, 1-31.

Pinkterton, M. H., Bradford-Grieve, J., Wilson, P., & Thompson, D. (2010). Birds: trophic modelling of the Ross Sea Retrieved from http://www.niwa.co.nz/sites/default/files/02_birds_ccamlr_final.pdf as accessed on 23 March 2017.

Pirotta, E., Merchant, N. D., Thompson, P. M., Barton, T. R., & Lusseau, D. (2015). Quantifying the Effect of Boat Distrubance on Bottlenose Dolphin Foraging Activity. *Biological Conservation, 181*, 82-89.

Pitcher, K. W., & Calkins, D. G. (1981). Reproductive biology of steller sea lions in the Gulf of Alaska. *62*(3), 599-605.

Popper, A. N. (2003). Effects of anthropogenic sounds on fishes. *Fisheries Research, 28*(10), 24-31.

Popper, A. N. (2008). *Effects of Mid- and High-Frequency Sonars on Fish*. Newport, RI: Naval Undersea Warfare Center Division, Newport. p. 52.

Popper, A. N. (2014). *Classification of fish and sea turtles with respect to sound exposure*. Technical report prepared for ANSI-Accredited. Standards Committee. S3/SC1.

Popper, A. N. (2015). Man-made noise and aquatic Life: data, data gaps, and speculation. *The Journal of the Acoustical Society of America, 137*(4), 2245-2245.

Popper, A. N., & Fay, R. R. (2010). Rethinking sound detection by fishes. *Hearing Research*, 1-12.

Popper, A. N., Salmon, M., & Horch, K. W. (2001). Acoustic detection and communication by decapod crustaceans. *Journal of Comparative Physiology A, 187*(2), 83-89.

Popper, A. N., & Schilt, C. R. (2008). Hearing and acoustic behavior: Basic and applied considerations. In *Fish Bioacoustics* (pp. 17-48). New York, NY: Springer.

Popper, A. N., Smith, M. E., Cott, P. A., Hanna, B. W., MacGillivray, A. O., Austin, M. E., & Mann, D. A. (2005). Effects of Exposure to Seismic Airgun Use on Hearing of Three Fish Species. *Journal of the Acoustical Society of America, 117*(6), 3958-3971.

Postma, L., Dueck, L., Heide-Jørgensen, M., & Cosens, S. (2006). *Molecular genetic support of a single population of bowhead whales (Balaena mysticetus) in Eastern Canadian Arctic and Western Greenland waters*: Fisheries and Oceans.

Protection of the Arctic Marine Environment (PAME). (2013). Large Marine Ecosystems of the Arctic Area, Revision of the Arctic LME Map Retrieved

Quakenbush, L., Citta, J., George, J., Small, R., & Heide-Jørgensen, M. (2008). *Satellite tracking of the western Arctic stock of bowhead whales.* Paper presented at the Alaska Marine Science Symposium.

Quakenbush, L. T., Small, R. J., Citta, J. J., & George, J. C. (2010). Satellite tracking of Western Arctic bowhead whales. *Satellite Tracking of Western Arctic Bowhead Whales*, 69.

Quintillion Subsea Operations, L. (2016a). *Application for the incidental harassment authorization for the taking of marine mammals in conjunction with the Quintillion Subsea project, 2017*. Silver Spring, MD: NOAA (NMFS, Office of Protected Resources).

Quintillion Subsea Operations, L. (2016b). *Application for the taking of marine mammals in conjunction with proposed Alaska phase of the Quintillion Subsea Project, 2016: revised final*. Silver Spring, MD: NOAA (NMFS, Office of Protected Resources).

Ralph, C. J., & Miller, S. L. (1995). Offshore population estimates of marbled murrelets in California. In. Ralph Jr., C. L., Hunt, G. L., Raphael, M. G. & Piatt, J. F. (Eds.), *Ecology and conservation of the marbled murrelet* (pp. 353-360). Albany, CA: Forest Service General Technical Report PSW-152.

Raphael, M. G., Shirk, A. J., Falxa, G. A., & Pearson, S. F. (2015). Habitat associations of marbled murrelets during the nesting season in nearshore waters along the Washington to California coast. *Journal of Marine Systems, 146*, 17-25. doi: http://doi.org/10.1016/j.jmarsys.2014.06.010.

Rasmussen, K., Palacios, D. M., Calambokidis, J., Saborío, M. T., Dalla Rosa, L., Secchi, E. R., . . . Stone, G. S. (2007). Southern Hemisphere humpback whales wintering off Central America: insights from water temperature into the longest mammalian migration. *Biology letters, 3*(3), 302-305.

Raven J.K., Caldeira, K., Elderfield, H., Hoegh-Guldberg, O., Liss, P., Riebesell, U., . . . Watson, A. (2005). *Ocean acidification due to atmospheric carbon dioxide*. London: The Royal Society. Available at: https://royalsociety.org/topics-policy/publications/2005/ocean-acidification/.

Ray, C. E. (1971). Polar bear and mammoth on the Pribilof Islands. *Arctic, 24*, 9-19.

Redfern, J. V., Hatch, L. T., Caldow, C., DeAngelis, M. L., Gedamke, J., Hastings, S., . . . Porter, M. B. (2017). Assessing the risk of chronic shipping noise to baleen whales off Southern California, U.S.A. *Endangered Species Research, 32*, 153-167.

Redfern, J. V., McKenna, M. F., Moore, T. J., Calambokidis, J., DeAngelis, M. L., Becker, E. A., . . . Chivers, S. J. (2013). Assessing the Risk of Ships Striking Large Whales in Marine Spatial Plannin. *Conservation Biology, 27*(2), 292-302.

Reeves, R. R. (1999). *Marine mammals in the area served by the South Pacific Regional Environment Programme (SPREP)*: South Pacific Regional Environment Programme.

Reeves, R. R. (2002). The origins and character of 'aboriginal subsistence' whaling: a global review. *Mammal Review, 32*, 71-106.

Reeves, R. R., Clapham, P. J., Brownell, J. R. L., & Silber, G. K. (1998). *Recovery plan for the blue whale (Balaenoptera musculus)*. Silver Spring, MD: National Marine Fisheries Service, Office of Protected Resources. p. 39.

Reeves, R. R., Stewart, B. S., Clapham, P. J., & Powell, J. A. (2002). *National Audubon Society Guide to Marine Mammals of the World*. In (pp. 527). New York, NY: Alfred A. Knopf.

Reeves, R. R., Stewart, B. S., & Leatherwood, S. (1992). *The Sierra Club handbook of seals and sirenians*. In (pp. 359). San Francisco, CA: Sierra Club Books.

Reeves, R. R., & Tracy, S. (1980). Monodon monoceros. In *Mammalian Species* (Vol. No. 127, pp. 1-7): The American Society of Mammologists.

Regehr, E. V., Amstrup, S. C., & Stirling, I. (2006). *Polar bear population status in the southern Beaufort Sea*. (Open-File Report 2006-1337). Reston, VA: U.S. Department of the Interior, U.S. Geological Survey. p. 20.

Regehr, E. V., Laidre, K. L., Akçakaya, H. R., Amstrup, S. C., Atwood, T. C., Lunn, N. J., . . . Wiig, Ø. (2016). Conservation status of polar bears (Ursus maritimus) in relation to projected sea-ice declines. *Biology Letters, 12*(12). doi: 10.1098/rsbl.2016.0556.

Reichmuth, C., Holt, M. M., Mulsow, J., Sills, J. M., & Southall, B. L. (2013). Comparative assessment of amphibious hearing in pinnipeds. *Journal of Comparative Physiology, 199*(6), 491-507.

Reichmuth, C., Mulsow, J., Finneran, J. J., Houser, D. S., & Supin, A. Y. (2007). Measurement and response characteristics of auditory brainstem responses in pinnipeds. *Aquatic Mammals, 33*(1), 132.

Reilly, S. B., Bannister, J. L., Best, P. B., Brown, M., Brownell Jr, R., Butterworth, D. S., . . . Zerbini, A. N. (2008a). Eubalaena japonica. The IUCN Redlist of Threatened Species 2008 Retrieved

Reilly, S. B., Bannister, J. L., Best, P. B., Brown, M. W., Brownell Jr, R. L., Butterworth, D. S., . . . Zerbini, A. N. (2008b). *Eschrichtius robustus*. *The IUCN Red List of Threatened Species. Version 2014.2* Retrieved from www.iucnredlist.org as accessed on 4 August 2014.

Reilly, S. B., & Thayer, V. G. (1990). Blue whale (Balaenoptera musculus) distribution in the eastern tropical Pacific. *Marine Mammal Science, 6*(4), 265-277.

Renaud, M. L., & Carpenter, J. A. (1994). Movements and submergence patterns of loggerhead turtles (Caretta caretta) in the Gulf of Mexico determined through satellite telemetry. *Bulletin of Marine Science, 55*(1), 1-15.

Rice, C. A., Duda, J. J., Greene, C. M., & Karr, J. R. (2012). Geographic Patterns of Fishes and Jellyfish in Puget Sound Surface Waters. *Marine and Coastal Fisheries, 4*(1), 117-128. doi: 10.1080/19425120.2012.680403.

Rice, D. (1977). Synopsis of biological data on the sei whale and Bryde's whale in the eastern North Pacific. *Report of the International Whaling Commission (Special Issue 1)*, 92-97.

Rice, D. W. (1974). Whales and whale research in the eastern north Pacific. In *The Whale Problem: A Status Report* (pp. 170-195). Cambridge, MA: Harvard University Press.

Rice, D. W. (1989). Sperm whale *Physeter macrocephalus* Linnaeus, 1758. In In. Ridgway , S. H. & Harrison, R. (Eds.), *Handbook of Marine Mammals* (Vol. 4: River dolphins and the larger toothed whales, pp. 177-234). San Diego, CA: Academic Press.

Rice, D. W. (1998). *Marine mammals of the world: systematics and distribution*. (Special Publication Number 4). Lawrence, KS: Society for Marine Mammology,. p. 231.

Richard, P. R., Martin, A. R., & Orr, J. R. (2001). Summer and autumn movements of belugas of the eastern Beaufort Sea stock *Arctic, 54*, 223-236.

Richardson, W. J., Fraker, M. A., Würsig, B., & Wells, R. S. (1985). Behaviour of bowhead whales (Balaena mysticetus) summering in the Beaufort Sea: Reactions to industrial activities. *Biological Conservation, 32*, 195-230.

Richardson, W. J., Green, C. R., Malme, C. I., & Thomson, D. H. (1995). *Marine Mammals and Noise*. San Diego, CA: Academic Press.
Richardson, W. J., Jr., C. R. G., Malme, C. I., & Thomson, D. H. (1991). *Effects of Noise on Marine Mammals*. (OCS Study MMS 90-0093). Herndon, VA: U.S. Department of the Interior, Minerals Management Service, Atlantic OCS Region. p. 462.
Richter-Menge, J., & Overland, J. E. (2010). Arctic Report Card 2010 Retrieved from http://www.arctic.noaa.gov/reportcard as accessed on 09 Novemeber 2010.
Richter, C., Gordon, J., Jaquet, N., & Würsig, B. (2008). Social structure of sperm whales in the northern Gulf of Mexico. *Gulf Mex. Sci, 26*(2), 118-123.
Richter, C. F., Dawson, S. M., & Slooten, E. (2003). *Sperm Whale Watching off Kaikoura, New Zealand: Effects of Current Activities on Surfacing and Vocalisation Patterns*. (Science for Conservation 219). Wellington, New Zealand: Department of Conservation. p. 78.
Ridgway, S. H., Wever, E. G., McCormick, J. G., Palin, J., & Anderson, J. H. (1969). Hearing in the giant sea turtle, Chelonia mydas. *Proceedings of the National Academy of Sciences, 64*(3), 884-890.
Roberts, L., & Breithaupt, T. (2016). Sensitivity of Crustaceans to Substrate-Borne Vibration. In *The Effects of Noise on Aquatic Life II* (pp. 925-931): Springer.
Roberts, S., & Hirshfield, M. (2003). *Deep Sea Corals: Out of Sight, But No Longer Out of Mind*. Washington, D.C.: Oceana. p. 20.
Robson, B. W. (2002). *Fur Seal Investigations, 2000-2001*. National Oceanic and Atmospheric Administration (NOAA). p. 80.
Rocha, R. C., Clapham, P. J., & Ivashchenko, Y. V. (2014). Emptying the oceans: a summary of industrial whaling catches in the 20th century. *Marine Fisheries Review, 76*(4), 37-48.
Rogers, D. E. (1986). Pacific Salmon. In. Hood, D. W. & Zimmerman, S. T. (Eds.), *The Gulf of Alaska: Physical Environmental and Biological Resources* (pp. 461-476). Anchorage, Alaska: Minerals Management Service.
Rogers, D. E., Rogers, B. J., & Rosenthal, R. J. (1986). The Nearshore Fishes. In. Hood, D. W. & Zimmerman, S. T. (Eds.), *The Gulf of Alaska: Physical Environment and Biological Resources* (pp. 399-415). Anchorage, Alaska: Minerals Management Service.
Ross, D. (1976). *Mechanics of Underwater Noise*. New York: Pergamon Press.
Ross, G. J. B. (1984). The smaller cetaceans of the southeast coast of Africa. *Annals of the Cape Provincial Museums (natural history), 15*(2), 173-410.
Roth, E. H., Schmidt, V., Hildebrand, J. A., & Wiggins, S. M. (2013). Underwater radiated noise levels of a research icebreaker in the central Arctic Ocean. *Journal of Acoustical Society of America, 133*(4), 1971-1980.
Rozema, P., Venables, H., Poll, W., Clarke, A., Meredith, M., & Buma, A. (2017). Interannual variability in phytoplankton biomass and species composition in northern Marguerite Bay (West Antarctic Peninsula) is governed by both winter sea ice cover and summer stratification. *Limnology and Oceanography, 62*(1), 235-252.
Rugh, D. J., DeMaster, D. P., Rooney, A., Breiwick, J. M., Shelden, K. E. W., & Moore, S. (2003). A review of bowhead whale (*Balaena mysticetus*) stock identity. *Journal of Cetacean Research and Management, 5*(3), 267-280.
Rugh, D. J., & Shelden, K. E. (2009). Bowhead whale: Balaena mysticetus.

Ryals, B. M., Dooling, R. J., Westbrook, E., Dent, M. L., Mackenzie, A., & Larsen, O. N. (1999). Avian species differences in susceptibility to noise exposure. *Hearing research, 131*(1), 71-88.

Ryals, B. M., Stalford, M. D., Lambert, P. R., & Westbrook, E. W. (1995). Recovery of noise-induced changes in the dark cells of the quail tegmentum vasculosum. *Hearing research, 83*(1), 51-61.

Ryan, P. G. (1991). The impact of the commercial lobster fishery on seabirds at the Tristan da Cunha Islands, South Atlantic Ocean. *Biological Conservation, 57*, 339-350.

Sala, A., Azzali, M., & Russo, A. (2002). Krill of the Ross Sea: distribution, abundance and demography of Euphausia superba and Euphausia crystallorophias during the Italian Antarctic Expedition (January-February 2000). *Scientia Marina, 66*(2), 123-133.

Salden, D. R., & Michelsen, J. (1999). Rare sighting of a North Pacific right whale (Eubalaena glacialis) in Hawaii. *Pacific Science, 53*(4), 341.

Salo, E. O. (1991). Life History of Chum Salmon (*Oncorhynchus keta*). In. Groot, C. & Margolis, L. (Eds.), *Pacific Salmon Life Histories* (pp. 231-309). Vancouver, British Columbia: UBC Press.

Samaran, F., Stafford, K. M., Branch, T. A., Gedamke, J., Royer, J.-Y., Dziak, R. P., & Guinet, C. (2013). Seasonal and geographic variation of southern blue whale subspecies in the Indian Ocean. *PLoS One, 8*(8), e71561.

Sandercock, F. K. (1991). Life History of Coho Salmon (*Oncorhynchus kisutch*). In. Groot, C. & Margolis, L. (Eds.), *Pacific Salmon Life Histories* (pp. 395-445). Vancouver, British Columbia: UBC Press.

Sanders, H. L. (1968). Marine benthic diversity: A comparitive study. *American Naturalist, 102*, 243-282.

Sanger, G. A. (1987). Winter diets of common murres and marbled murrelets in Kachemak Bay, Alaska. *Western Birds, 89*, 426-430.

Sasso, C. R., & Epperly, S. P. (2006). Seasonal sea turtle mortality risk from forced submergence in bottom trawls. *Fisheries Research, 81*(1), 86-88.

Sato, C. L. (2016a). *Periodic status review for the Leatherback Sea Turtle in Washington*. Olympia, Washington: Washington Department of Fish and Wildlife.

Sato, C. L. (2016b). *Periodic status reviews for the Green and Loggerhead Sea Turtles in Washington.* Olympia, Washington: Washington Department of Fish and Wildlife.

Sato, K., Naito, Y., Kato, A., Niizuma, Y., Watanuki, Y., Charrassin, J. B., . . . Le Maho, Y. (2002). Buoyancy and maximal diving depth in penguins. *Journal of Experimental Biology, 205*(9), 1189.

Saunders, J., & Dooling, R. (1974). Noise-induced threshold shift in the parakeet (Melopsittacus undulatus). *Proceedings of the National Academy of Sciences, 71*(5), 1962-1965.

SCAR. (2002). *Report of GOSEAC Meeting*. College Station, Texas.

Scarff, J. E. (1986). *Historic and present distribution of the right whale (Eubalaena glacialis) in the eastern north Pacific south of 50°N and east of 180°W*. Paper presented at the Right Whales: Past and Present Status: Proceedings of the Workshop on the Status of Right Whales, New England Aquarium, Boston, Massachusetts.

Scheffer, V. B. (1958). *Seals, sea lions and walruses: A review of the Pinnipedia*. Stanford, CA: Stanford University Press.

Schine, C. M. S., van Dijken, G., & Arrigo, K. R. (2016). Spatial analysis of trends in primary production and relationship with large scale climate variability in the Ross Sea, Antarctica *Journal of Geophysical Research: Oceans, 121*(1), 368-386. doi: 10.1002/2015JC011014.

Schliebe, S., Amstrup, S., & Garner, G. (1995). *The status of polar bear in Alaska, 1993.* Paper presented at the Proceedings of the Eleventh Working Meeting of the IUCN/SSC Polar Bear Specialist Group. IUCN, Gland, Switzerland, and Cambridge, UK.

Schnappinger, C., & ABS Consulting. (2011). *U.S. Polar Icebreaker Recapitalization: A Comprehensive Analysis and its Impacts on U.S. Coast Guard Activities (October 2011)*. Washington, DC.

Schrappen, P. (2014). *Recreational Boating Barriers and Opportunities*. Northwest Marine Trade Assoc. 2014 Meeting.

Schreiber, R. W., & Chovan, J. L. (1986). Roosting by pelagic seabirds: Energetic, populational, and social considerations. *The Condor, 88*(4), 487-492.

Schusterman, R. J. (1981). Steller sea lion *Eumetopias jubatus* (Schreber, 1776). In. Ridgway , S. H. & Harrison, R. J. (Eds.), *Handbook of Marine Mammals: The walrus, sea lions, fur seals, and sea otter* (Vol. 1, pp. 119-141): Academic Press.

Schusterman, R. J., Balliet, R. F., Nixon, J. S., R. J., Balliet, R. F., & Nixon, J. (1972). Underwater audiogram of the California sea lion by the conditioned vocalization technique. *Journal of the Experimental Analysis of Behavior, 17*, 339-350.

Schusterman, R. J., & Moore, P. W. B. (1978). Underwater audiogram of the northern fur seal (Callorhinus ursinus). *The Journal of the Acoustical Society of America, 64*(81), S87-S87.

Schwartz, A. L. (1985). The behavior of fishes in their acoustic environment. *Environmental Biology of Fishes, 13*(1), 3-15.

Scientific Committee on Antarctic Research (SCAR). (2016). *Antarctic Climate Change and the Environment - 2016 Update.* Presented at the 2016 39th Antarctic Treaty Consultative Meeting. Santiago, Chile.

Sease, J. L., & Gudmundson, C. J. (2002). *Aerial and land-based surveys of Steller sea lions (Eumetopias jubatus) from the western stock in Alaska, June and July 2001 and 2002*. (NOAA Technical Memorandum NMFS-AFSC-131). National Oceanic and Atmospheric Administration (NOAA).

Sease, J. L., & York, A. E. (2003). Seasonal distribution of Steller's sea lions at rookeries and haul-out sites in Alaska. *19*(4), 745-763.

Secretariat of the Pacific Regional Environmental Programme (SPREP). (2007). *Pacific Islands Regional Marine Species Programme 2008-2012*. Apia, Samoa.

Sergeant, D. E., & Brodie, P. F. (1969). Body size in white whales, Delphinapterus leucas. *Journal of Fisheries Research Board of Canada, 26*, 2561-2580.

Serreze, M. C., Maslanik, J. A., Scambos, T. A., Fetterer, F., Stroeve, J., Knowles, K., . . . Haran, T. M. (2003). A Record Minimum Arctic Sea Ice Extent and Area in 2002. *Geophysical Research Letters, 30*(3), 10/1-10/4.

Shah, A. A., Hasan, F., Hameed, A., & Ahmed, S. (2008). Biological degradation of plastics: A comprehensive review. *Biotechnology Advances, 26*, 246-265.

Shelden, K. E., Moore, S. E., Waite, J. M., Wade, P. R., & Rugh, D. J. (2005). Historic and current habitat use by North Pacific right whales Eubalaena japonica in the Bering Sea and Gulf of Alaska. *Mammal Review, 35*(2), 129-155.

Sibley, D. A. (2007). *National Audubon Society: The sibley guide to birds*. New York, NY: Chanticleer Press.

Sigler, M. F., Stabeno, P. J., Eisner, L. B., Napp, J. M., & Mueter, F. J. (2014). Spring and fall phytoplankton blooms in a productive subarctic ecosystem, the eastern Bering Sea, during 1995–2011. *Deep Sea Research Part II: Topical Studies in Oceanography, 109*, 71-83.

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

Simmonds, M. P., & Isaac, S. J. (2007). The impacts of climate change on marine mammals: Early signs of significant problems. *Oryx, 41*(1), 19-26.

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. *26*, 577-586.

Simpson, S. D., Radford, A. N., Tickle, E. J., Meekan, M. G., & Jeffs, A. G. (2011). Adaptive avoidance of reef noise. *PLoS One, 6*(2), 1-5.

Sirenko, B. I. (2001). List of species of free-living invertebrates of Eurasian Arctic seas and adjacent deep waters. *Explorations of the Fauna of the Seas, 51*(59).

Sirenko, B. I., Clarke, C., Hopcroft, R. R., Huettmann, F., Bluhm, B. A., & Gradinger, R. (2010). The Arctic Register of Marine Species (ARMS) compiled by the Arctic Ocean Diversity (ArcOD) Retrieved from http://www.marinespecies.org/arms as accessed on 2 September 2014.

Širović, A., Hildebrand, J. A., Wiggins, S. M., McDonald, M. A., Moore, S. E., & Thiele, D. (2004). Seasonality of blue and fin whale calls and the influence of sea ice in the Western Antarctic Peninsula. *Deep Sea Research Part II: Topical Studies in Oceanography, 51*(17), 2327-2344.

Skov, H., Gunnlaugsson, T., Budgell, W., Horne, J., Nøttestad, L., Olsen, E., . . . Waring, G. (2008). Small-scale spatial variability of sperm and sei whales in relation to oceanographic and topographic features along the Mid-Atlantic Ridge. *Deep Sea Research Part II: Topical Studies in Oceanography, 55*(1), 254-268.

Slabbekoorn, H., Bouton, N., Opzeeland, I. C. V., Coers, A., Cate, C. t., & Popper, A. N. (2010). A noisy spring: The impact of globally rising underwater sound levels on fish. *Trends in Ecology and Evolution, 25*(7), 419-427.

Sleptsov, M. M. (1970). *Fluctuations in the number of whales of the Chukchi Sea in various years (O Kolebanii Chislennosti Kitov v Chukotskom More v Raznye Gody)*. DTIC Document.

Smith, C. R., Baco-Taylor, A. R., Hannides, A., & Ruplinger, D. (2003). *Chemosynthetic Habitats on the California Slope: Whale-, Wood- and Kelp-Falls Compared to Vents and Seeps.* Paper presented at the Biogeography and Biodiversity of Chemosynthetic Ecosystems: Planning for the Future, UNESS Workshop, Southampton.

Smith, M. E., Kane, A. S., & Popper, A. N. (2004). Acoustical Stress and Hearing Sensitivity in Fishes: Does the Linear Threshold Shift Hypothesis Hold Water? *The Journal of Experimental Biology, 207*, 3591-3602.

Smith, R. C., Dustan, P., Au, D., Baker, K. S., & Dunlap, E. A. (1986). Distribution of Cetaceans and Sea-Surface Chlorophyll Concentrations in the California Current. *Marine Biology, 91*, 385-402.

Smith, T. G. (1981). *Notes on the bearded seal, Erignathus barbatus, in the Canadian Arctic*. (Canadian Technical Report of Fisheries and Aquatic Sciences No. 1042). Quebec: Canada Department of Fisheries and Oceans, Arctic Biological Station. p. 49.

Smith, T. G., Beck, B., & Sleno, G. A. (1973). Capture, handling, and branding of ringed seals. *The Journal of Wildlife Management*, 579-583.

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*(9), 1297-1305.

Smith, W. O., Ainley, D. G., Arrigo, K. R., & Dinniman, M. S. (2014). The Oceanography and Ecology of the Ross Sea. *Annual Review of Marine Science, 6*(1), 469-487. doi: 10.1146/annurev-marine-010213-135114.

Smith, W. O., Ainley, D. G., & Cattaneo-Vietti, R. (2007). Trophic interactions within the Ross Sea continental shelf ecosystem. *Philosophical Transactions of the Royal Society of London B: Biological Sciences, 362*(1477), 95-111.

Smultea, M. A., Jefferson, T. A., & Zoidis, A. M. (2010). Rare Sightings of a Bryde's Whale (Balaenoptera edeni) and Sei Whales (B. borealis)(Cetacea: Balaenopteridae) Northeast of O'ahu, Hawai'i 1. *Pacific Science, 64*(3), 449-457.

Soldevilla, M. S., Wiggins, S. M., & Hildebrand, J. A. (2009). Spatial and temporal patterns of Risso's dolphin echolocation in the Southern California Bight. *Journal of Acoustical Society of America*, 124-132. doi: DOI: 10.1121/1.3257586.

Southall, B. L. (2005). *Final Report of the National Oceanic and Atmospheric Administration (NOAA) International Symposium: "Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology," 18-19 May 2004, Arlington, Virginia, U.S.A*. National Oceanic and Atmospheric Administration (NOAA).

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., Schusterman, R. J., & Kastak, D. (2000). Masking in three pinnipeds: Underwater, low-frequency critical ratios. *Journal of the Acoustical Society of America, 108*(3), 1322-1326.

Spear, L. B., & Ainley, D. G. (1997). Flight behaviour of seabirds in relation to wind direction and wing morphology. *Ibis, 139*(2), 221-233.

Spence, B. C., & Hall, J. D. (2010). Spatiotemporal patterns in migration timing of coho salmon (Oncorhynchus kisutch) smolts in North America. *Canadian Journal of Fisheries and Aquatic Sciences, 67*(8), 1316-1334. doi: 10.1139/F10-060.

Springer, A. M., & Roseneau, D. G. (1985). Copepod-based food webs: auklets and oceanography in the Bering Sea. *Marine Ecology Progress Series, 21*, 229-237.

Staaterman, E. (2016). Passive acoustic monitoring in benthic marine crustaceans: A new research frontier. In *Listening in the Ocean*. New York, NY: Springer.

Staaterman, E. R., Clark, C. W., Gallagher, A. J., deVries, M. S., Claverie, T., & Patek, S. N. (2011). Rumbling in the benthos: acoustic ecology of the California mantis shrimp *Hemisquilla californiensis*. *Aquatic Biology, 13*, 97-105.

Stabeno, P. J., Kachel, N. B., Moore, S. E., Napp, J. M., Sigler, M., Yamaguchi, A., & Zerbini, A. N. (2012). Comparison of warm and cold years on the southeastern Bering Sea shelf and some implications for the ecosystem. *Deep Sea Research Part II: Topical Studies in Oceanography, 65*, 31-45.

Stafford, K. M. (2003). Two types of blue whale calls recorded in the Gulf of Alaska. *Marine Mammal Science, 19*(4), 682-693.

Stafford, K. M., Nieukirk, S. L., & Fox, C. G. (1999). An Acoustic Link Between Blue Whales in the Eastern Tropical Pacific and the Northeast Pacific. *15*(4), 1258-1268.

Stafford, K. M., Nieukirk, S. L., & Fox, C. G. (2001). Geographic and seasonal variation of blue whale calls in the North Pacific. *Journal of Cetacean Research and Management, 3*(1), 65-76.

Stamation, K., Croft, D. B., Shaughnessy, P. D., Waples, K., & Briggs, S. V. (2009). Behavioral responses of humpback whales (Megaptera novaengliae) to whale-watching vessels on the southeastern coast of Australia. *Marine Mammal Science, 26*(1), 98-122.

Stammerjohn, S. E., Martinson, D. G., Smith, R. C., Yuan, X., & Rind, D. (2008). Trends in Antarctic annual sea ice retreat and advance and their relation to El Niño–Southern Oscillation and Southern Annular Mode variability. *Journal of Geophysical Research: Oceans, 113*(C3), n/a-n/a. doi: 10.1029/2007JC004269.

State of Alaska Department of Transportation and Public Facilities, & U.S. DoT FHA. (2013). *Kotzebue to Cape Blossom Road Environmental Assessment* (Project No. NCPD-0002(204)/76884). Northern Region.

Stephen R. Braund Associates. (2012). *Summary of Marine Subsistence Uses: Barrow and Wainwright, Alaska*. Anchorage, Alaska: Pew Charitable Trusts' US Arctic Program.

Stimpert, A. K. (2010). *Non-song sound production and its behavioral context in humpback whales (Megaptera novaeangliae).* Doctoral Dissertation, University of Hawaii at Manoa.

Stirling, I. (1997). The importance of polynyas, ice edges, and leads to marine mammals and birds. *10*, 9-21.

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. *52*(3), 294-306.

Stoker, S. W., & Krupnik, I. I. (1993). Subsistence whaling. Pp. 579-629 *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Stone, C. J., & Tasker, M. L. (2006). The effect of seismic airguns on cetaceans in UK waters. *Journal of Cetacean Research and Management, 8*, 255–263.

Stone, R. P., & Shotwell, S. K. (2007). *State of deep coral ecosystems in the Alaska Region: Gulf of Alaska, Bering Sea and the Aleutian Islands*. Silver Spring, Maryland: NOAA. pp. 65-108.

Strachan, G., McAllister, M., & Ralph, C. J. (1995). Marbled murrelet at-sea and foraging behavior. In. Ralph Jr., C. L., Hunt, G. L., Raphael, M. G. & Piatt, J. F. (Eds.), *Ecology and conservation of the marbled murrelet* (pp. 247-253). Albany, CA: Forest Service General Technical Report PSW-152.

Stringer, W. (1974). Morphology of the Beaufort Sea shorefast ice. *The coast and shelf of the Beaufort Sea*, 165-172.

Stumpf, J. P., Denis, N., Hamer, T. E., Johnson, G., & Verschuyl, J. (2011). Flight height distribution and collision risk of the marbled murrelet (Brachyramphus marmoratus): Methodology and preliminary results. *Marine Ornithology, 39*, 123-128.

Suisted, R., & Neale, D. (2004). *Department of Conservation Marine Mammal Action Plan for 2005-2010*. Wellington, NZ: Department of Conservation.

Supin, A. Y., Popov, V. V., & Mass, A. M. (2001). Hearing in Cetaceans. In *The Sensory Physiology of Aquatic Mammals* (pp. 19-204). U.S.: Springer.

Suydam, R. (2009). *Age, growth, reproduction, and movements of beluga whales (Delphinapterus leucas) from the eastern Chukchi Sea.* Ph.D. (Dissertation), University of Washington.

Sydeman, W. J., M. Losekoot, J.A. Santora, S.A. Thompson, T. Distler, T., A. Weinstein, & Morgan, K. (2012). *Hotspots of Seabird Abundance in the California Current: Implications for Important Bird Areas*. California: Audubon Society.

Symon, C., Arris, L., & Heal, B. (Eds.). (2005). *Arctic Climate Impact Assessment*. New York, NY: Cambridge University Press.

TCW Economics. (2008). *Economic analysis of the non-treaty commercial and recreational fisheries in Washington State.* Sacramento, CA. With technical assistance from The Research Group, Corvallis, OR. .

Terhune, J. M., & Ronald, K. (1975). Underwater hearing sensitivity of two ringed seals (*Pusa huspida*). *Canadian Journal of Zoology, 50*, 565-569.

Therrien, S. C. (2014). *In-air and underwater hearing of diving birds.* University of Maryland, College Park, MD. Retrieved from http://drum.lib.umd.edu/handle/1903/15742

Thomas, A. C., & Weatherbee, R. A. (2006). Satellite-measured temporal variability of the Columbia River plume. *Remote Sensing of Environment, 100*(2), 167-178. doi: http://doi.org/10.1016/j.rse.2005.10.018.

Thompson, D., Sjoberg, M., Bryant, M. E., Lovell, P., & Bjorge, A. (1998). *Behavioural and physiological responses of harbour (Phoca vitulina) and grey (Halichoerus grypus) seals to seismic surveys*. European Commission of BROMMAD Project

Thoresen, A. C. (1989). Diving times and behavior of pigeon guillemots and marbled murrelets off Rosario Head, Washington. *Western Birds, 20*(1), 33-37.

Thurman, H. V., & Burton, E. A. (1997). Introductory Oceanography.

Tiller, V. E. V. (2015a). Makah Reservation, Washington. In *Tiller's Guide to Indian Country: Economic Profiles of American Indian Reservations* (pp. 747-751). Albuquerque, NM: BowArrow Publishing Company.

Tiller, V. E. V. (2015b). Quileute Reservation, Washington. In *Tiller's Guide to Indian Country: Economic Profiles of American Indian Reservations* (pp. 760-762). Albuquerque, NM: BowArrow Publishing Company.

Tillman, M. (1977). Estimates of population size for the North Pacific sei whale. *Rep. int. Whal. Commn, 1*, 98-106.

Timmermans, M. L., Proshutinsky, A., Golubeva, E., Jackson, J. M., Krishfield, R., McCall, M., . . . Nishino, S. (2014). Mechanisms of Pacific summer water variability in the Arctic's Central Canada basin. *Journal of Geophysical Research, 119*(11), 7523-7548.

Tollefson, J. (2016). The hostile ocean that slowed climate change. *Nature, 539*, 346-348.

Tomilin, A. (1937). Whales of the Russian Far East. *proceedings of Moscow State University, Moscow, USSR Nauka, 23*, 119-167.

Tomilin, A. (1967). Cetacea: Mammals of the USSR and Adjacent Countries, vol. 9. *Jerusalem: Israel Program for Scientific Translations*.

Tougaard, J., Wright, A. J., & Madsen, P. T. (2014). Cetacean noise criteria revisited in the light of proposed exposure limits for harbour porpoises. *Marine Pollution Bulletin, 90*(1), 96-208.

Trites, A. W., & Bain, D. E. (2000). *Short- and long-term effects of whale watching on killer whales (Orcinus orca) in British Columbia* Adelaide, Australia: International Whaling Commission. p. 10.

Tubelli, A., Zosuls, A., Ketten, D., & Mountain, D. C. (2012). Prediction of a mysticete audiogram via finite element analysis of the middle ear. In *The Effects of Noise on Aquatic Life* (pp. 57-59): Springer.

Turnpenny, A. W., & Nedwell, J. R. (1994). *The Effects on Marine Fish, Diving Mammals and Birds of Underwater Sound Generated by Seismic Surveys: Consultancy Report*. Fawley Aquatic Research Laboratories.

Tyack, P. L. (2008). Implications for marine mammals of large-scale changes in the marine acoustic environment. *Journal of Mammalogy, 89*(3), 549-558.

Tynan, C. T. (1999). Redistributions of cetaceans in the southeast Bering Sea relative to anomalous oceanographic conditions during the 1997 El Niño. *PICES scientific report. Sidney BC*(10), 115-117.

Tynan, C. T., DeMaster, D. P., & Peterson, W. T. (2001). Endangered right whales on the southeastern Bering Sea shelf. *Science, 294*(5548), 1894-1894.

Tyurneva, O. Y., Yakovlev, Y. M., Vertyankin, V. V., & Selin, N. I. (2010). The peculiarities of foraging migrations of the Korean-Okhotsk gray whale (Eschrichtius robustus) population in Russian waters of the Far Eastern seas. *Russian Journal of Marine Mammalogy, 36*(2), 117-124.

U.S. Coast Guard. (2011). *CGD17INST 16214.2A: Marine Protected Species Prograom for the Gulf of Alaska, Bering Sea/Aleutian Islands, and Arctic.*: U.S. Coast Guard.

U.S. Coast Guard. (2013a). *Final Programmatic Environmental Assessment for the Nationwide Use of High Frequency (HF) and Ultra High Frequency (UHF) Active SONAR Technology*. Washington, D.C.

U.S. Coast Guard. (2013b). *United States Coast Guard Arctic Strategy*. Washington, D.C.

U.S. Coast Guard. (2016). *Environmental Assessment for U.S. Coast Guard Arctic Operations and Training Exercises 2016*. Alaska.

U.S. Coast Guard. (n.d.). USCG icebreakers Archived Cruise Reports Retrieved from http://icefloe.net/archived-cruise-reports as accessed on August 2017.

U.S. Department of the Navy. (2006). Marine Resources Assessment for the Pacific Northwest Operating Area. Final report. Retrieved from http://www.navfac.navy.mil/content/dam/navfac/Environmental/PDFs/MRA/PACNW_MRA_Sept2006.pdf as accessed on 24 August 2011.

U.S. Department of Transportation. (2017). Port of Seattle Seaport Statistics: Vessel Calls Retrieved from https://www.portseattle.org/About/Publications/Statistics/Seaport/Pages/Vessel-Calls.aspx as accessed on 12 May 2017.

U.S. Fish and Wildlife Service. (2001). BIOLOGICAL OPINION: The Effects of Constructing a New Addition to the Harbor in Sand Point, Alaska, on the Threatened Steller's Eider (Polysticta stelleri). Retrieved from https://www.fws.gov/alaska/fisheries/endangered/pdf/Sandpoint.pdf

U.S. Fish and Wildlife Service. (2003). Threatened and Endangered Species: Spectacled Eider (Somateria fischeri). Retrieved from https://www.fws.gov/uploadedFiles/Region_7/NWRS/Zone_1/Yukon_Delta/PDF/spei%20final%20web.pdf

U.S. Fish and Wildlife Service. (2011). Threatened and Endangered Species Fact Sheet - Steller's Eider (Polysticta stelleri) Retrieved from https://www.fws.gov/alaska/fisheries/fieldoffice/anchorage/endangered/pdf/factsheet_stei.pdf

U.S. Fish and Wildlife Service. (2014). Natural History - Polar Bears (Ursus maritimus) Retrieved from http://www.fws.gov/alaska/fisheries/mmm/polarbear/facts.htm

U.S. Fish and Wildlife Service. (2016). Endangered and Threatened Wildlife and Plants; Determination of Critical Habitat for the Marbled Murrelet. *Federal Register, 81*(150), 51348-51370.

U.S. Government Accountability Office. (2018). *Coast Guard Acquisitions: Status of Coast Guard's Heavy Polar Icebreaker Acquisition*. Washington, DC.

U.S. Navy. (2014a). *Commander Task Force 3rd and 7th Fleet Navy Marine Species Density Database*. Pearl Harbor, HI. p. 486.

U.S. Navy. (2014b). *The United States Navy Arctic Roadmap for 2014 to 2030*. U.S. Navy. p. 47 pp.

U.S. Navy. (2015). *Guam and Commonwealth of the Northern Mariana islands Military Relocation (2012 Roadmap Adjustments), Final Supplemental Environmental Impact Statement*. Pearl Harbor, HI. p. 1596.

U.S. Navy. (2017a). *Dive Distribution and Group Size Parameters for Marine Species Occurring in the U.S. Navy's Atlantic and Hawaii-Southern California Training and Testing Areas. Technical report prepared by Naval Undersea Warfare Center, Newport*. Newport, RI.

U.S. Navy. (2017b). *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing. Technical report prepared by Space and Naval Warfare Systems Center Pacific and Naval Undersea Warfare Center, Newport*. Newport, RI.

Underwood, M. B., Hoke, K. D., Fisher, A. T., Davis, E. E., Giambalvo, E., Zühlsdorff, L., & Spinelli, G. A. (2005). Provenance, stratigraphic architecture, and hydrogeologic influence of turbidites on the mid-ocean ridge flank of northwestern Cascadia Basin, Pacific Ocean. *Journal of Sedimentary Research, 75*(1), 149-164. doi: 10.2110/jsr.2005.012.

UNEP. (2012). *Scientific synthesis on the impacts of underwater noise on marine and coastal biodiversity and habitats*. p. 93.

UNEP/CMS Secretariat. (2014). *A Review of Migratory Bird Flyways and Priorities for Management.* Bonn, Germany: CMS Technical Series No. 27.

United States Arctic Research Commission. (2010). About United States Arctic Research Commission Retrieved from http://www.arctic.gov/about.html as accessed on 03 December 2010.

United States Coast Guard. (1982). Navigation and Vessel Inspection Circular No. 12-82. Recommendations on Control of Excessive Noise.

Urawa, S., Sato, S., Crane, P., Agler, B., Josephson, R., & Azumaya, T. (2009). *Stock-specific ocean distribution and migration of chum salmon in the Bering Sea and North Pacific Ocean*. pp. 131-146.

Urbán, R., J., Weller, D., Tyurneva, O., Swartz, S., Bradford, A., Yakovlev, Y., . . . A., G.-G. U. (2013). *Report on the photographic comparison of the Sakhalin Island and Kamchatka Peninsula with the Mexican gray whale catalogues*. Paper SC/65a/BRG04 presented to the International Whaling Commission Scientific Committee [Available from http://www.iwcoffice.org/].

Urick, R. J. (1983). *Principles of Underwater Sound*. New York, NY: McGraw-Hill.

USCG Research and Development Center. (2010). *Polar Platform Business Case Analysis (June 2010)*.

USFWS. (1992). Endangered and threatened wildlife and plants: Determinations of threatened status of the Washington, Oregon, and California population of marbled murrelet. *Federal Register, 57*(191), 45328-45337.

USFWS. (1996). *Spectacled Eider (Somateria fischeri) Recovery Plan*. Anchorage, Alaska: Region 7, U.S. Fish and Wildlife Service. p. 157 p.

USFWS. (1997). *Recovery plan for the threatened marbled murrelet (Brachyramphus marmoratus) in Washington, Oregon, and California*. Portland, OR: U.S. Fish and Wildlife Service.

USFWS. (2000). Endangered and threatened wildlife and plants: Final rule to list the short-tailed albatross as endangered in the United States. *Federal Register, 65*(147), 46643-46654.

USFWS. (2002). *Steller's Eider Recovery Plan*. Fairbanks, Alaska.

USFWS. (2003). *Final Revised Recovery Plan for the Southern Sea Otter (Enhydra lutris nereis)*. Portland, Oregon. p. 165 p.

USFWS. (2005a). *Regional seabird conservation plan, Pacific region*. Portlant, OR: U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region. p. 264.

USFWS. (2005b). *Short-tailed albatross recovery plan*. Anchorage, AK. p. 62.

USFWS. (2009a). *Marbled murrelet (Brachyramphus marmoratus): 5-Year Review*. Lacey, WA: U.S. Fish and Wildlife Service Washington Fish and Wildlife Office. p. 108.

USFWS. (2009b). *Rat Island Habitat Restoration Project: MMPA Incidental Harassment Authorization Final Report*. Homer, AK: NMFS Office of Protected Resources.

USFWS. (2013a). *List of Migratory Species Protected by the Migratory Bird Treaty Act (MBTA) as of December 2, 2013*. U.S. Fish and Wildlife Service. p. 171 pgs.

USFWS. (2013b). *Southwest Alaska Distinct Population Segment of the Northern Sea Otter (Enhyra lutris keyoni) Recovery Plan*. Anchorage, Alaska: U.S. Fish and Wildlife Service, Region 7. p. 171 pgs.

USFWS. (2014). *5-Year Review: Summary and Evaluation. Short-tailed Albatross (Phoebastria albatrus).* Anchorage, Alaska: U.S. Fish and Wildlife Service, Anchorage Fish and Wildlife Field Office.

USFWS. (2016). *Polar Bear (Ursus maritimus) Conservation Management Plan, Final*. Anchorage, AK. p. 104.

Vabø, R., Olsen, K., & Huse, I. (2002). The effect of vessel avoidance of wintering Norwegian spring spawning herring. *Fisheries research, 58*(1), 59-77.

Van Ark, E. M., Detrick, R. S., Canales, J. P., Carbotte, S. M., Harding, A. J., Kent, G. M., . . . Babcock, J. M. (2007). Seismic structure of the Endeavour Segment, Juan de Fuca Ridge: Correlations with seismicity and hydrothermal activity. *Journal of Geophysical Research: Solid Earth, 112*(B2).

van Franeker, J. A., Gavrilo, M., Mehlum, F., Veit, R. R., & Woehler, E. J. (1999). Distribution and Abundance of the Antarctic Petrel. *Waterbirds: The International Journal of Waterbird Biology, 22*(1), 14-28. doi: 10.2307/1521989.

Van Waerebeek, K., Baker, A. N., Félix, F., Gedamke, J., Iñiguez, M., Sanino, G. P., . . . Wang, Y. (2007). Vessel collisions with small cetaceans worldwide and with large whales in the Southern Hemisphere, an initial assessment. *Latin American Journal of Aquatic Mammals, 6*(1), 43-69.

Vancoppenolle, M., Meiners, K. M., Michel, C., Bopp, L., Brabant, F., Carnat, G., . . . Moreau, S. (2013). Role of sea ice in global biogeochemical cycles: emerging views and challenges. *Quaternary science reviews, 79*, 207-230.

Vanderlaan, A. S., Corbett, J. J., Green, S. L., Callahan, J. A., Wang, C., Kenney, R. D., . . . Firestone, J. (2009). Probability and mitigation of vessel encounters with North Atlantic right whales. *Endangered Species Research*.

Vanderlaan, A. S., & Taggart, C. T. (2007). Vessel collisions with whales: the probability of lethal injury based on vessel speed. *Marine mammal science, 23*(1), 144-156.

Vanderlaan, A. S., Taggart, C. T., Serdynska, A. R., Kenney, R. D., & Brown, M. W. (2008). Reducing the risk of lethal encounters: vessels and right whales in the Bay of Fundy and on the Scotian Shelf. *Endangered Species Research*.

Veirs, S., Veirs, V., & Wood, J. D. (2016). Ship noise extends to frequencies used for echolocation by endangered killer whales. *PeerJ, 4*, e1657.

Vertyankin, V. V., Nikulin, V. C., A.M., B., & Kononov, A. P. (2004). Sighting of gray whales (*Eschrichtius robustus*) near southern Kamchatka.Pp 126-128 in: Marine Mammals of the Holarctic. *Collection of scientific papers of International Conference. Koktebel, Crimea, Ukraine, October 11-17, 2004*.

Vinas, M. J. (2017). Sea Ice Extent Sinks to Record Lows at Both Poles. Retrieved from

Virketis, M. A. (1957). Some data on the zooplankton from the central part of the Arctic Basin. In *Materials of scientific observations of the drift stations "North Pole 3" and "North Pole 4" 1954/1955* (pp. 238-311). Moscow, Russia.

Von Saunder, A., & Barlow, J. (1999). *A report of the Oregon, California and Washington Line-transect Experiment (ORCAWALE) conducted in west coast waters during summer/fall 1996*: US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Wade, P., De Robertis, A., Hough, K., Booth, R., Kennedy, A., LeDuc, R., . . . Rankin, S. (2011a). Rare detections of North Pacific right whales in the Gulf of Alaska, with observations of their potential prey. *Endangered Species Research, 13*(2), 99-109.

Wade, P., Heide-Jørgensen, M. P., Shelden, K., Barlow, J., Carretta, J., Durban, J., . . . Sauter, A. (2006). Acoustic detection and satellite-tracking leads to discovery of rare concentration of endangered North Pacific right whales. *Biology letters, 2*(3), 417-419.

Wade, P. R., Kennedy, A., LeDuc, R., Barlow, J., Carretta, J., Shelden, K., . . . Rone, B. (2011b). The world's smallest whale population? *Biology letters, 7*(1), 83-85.

Wadhams, P. (2000). *Ice in the Ocean*: CRC Press.

Wahl, T. R. (1970). A Short-Tailed Albatross Record for Washington State. *California Birds, 1*(3), 113-115.

Wahl, T. R. (1975). Seabirds in Washington's Offshore Zone. *Western Birds, 6*, 117-134.

Wahl, T. R., Morgan, K. H., & Vermeer, K. (1993). Seabird distribution off British Columbia and Washington. In. Vermeer, K., Briggs, K. T., Morgan, K. H. & Siegal-Causey, D. (Eds.), *The Status, Ecology, and Conservation of Marine Birds of the North Pacific* (pp. 39-47). Ottawa: Canadian Wildlife Service Special Publication.

Waite, J. M., Friday, N. A., & Moore, S. E. (2002). Killer whale (Orcinus orca) distribution and abundance in the central and southeastern Bering Sea, July 1999 and June 2000. *Marine Mammal Science, 18*(3), 779-786.

Waite, J. M., Wynne, K., & Mellinger, D. K. (2003). Documented sighting of a North Pacific right whale in the Gulf of Alaska and post-sighting acoustic monitoring. *Northwestern Naturalist, 84*(1), 38-43.

Wale, M. A., Simpson, S. D., & Radford, A. N. (2013). Noise negatively affects foraging and antipredator behaviour in shore crabs. *Animal Behaviour, 86*, 111-118.

Walker, W. A., & Coe, J. M. (1989). *Survey of marine debris ingestion by odontocete cetaceans.* Paper presented at the Proceedings of the Second International Conference on Marine Debris.

Wallace, B. P., Tiwari, M., & Girondot, M. (2013). *Dermochelys coriacea (West Pacific Ocean subpopulation).* The IUCN Red List of Threatened Species 2013: e.T46967817A46967821. http://dx.doi.org/10.2305/IUCN.UK.2013-2.RLTS.T46967817A46967821.en. Downloaded on 01 May 2017.

Walther, G.-R., Post, E., Convey, P., Menzel, A., Parmesan, C., Beebee, T. J. C., . . . Bairlein, F. (2002). Ecological Responses to Recent Climate Change. *Nature, 416*, 389-395.

Wang, P. (1985). *Distribution of cetaceans in Chinese waters*. NMFS.

Warrick, D. R., Bundle, M. W., & Dial, K. P. (2002). Bird Maneuvering Flight: Blurred Bodies, Clear Heads. *Integrative and Comparitive Biology*(42), 141-148.

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., & Ketten, D. R. (1999). *Marine mammal sensory systems*. Washington, DC: Smithsonian Institution Press.

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.

Wartzok, D., Watkins, W. A., Wursig, B., & Malme, C. I. (1989). *Movements and behaviors of bowhead whales in response to repeated exposures to noises associated with industrial activities in the Beaufort Sea.* . Anchorage, AK: Whale Research Report, AMOCO Production Co. p. 228.

Washington State Department of Ecology. (2017). Preliminary Draft Marine Spatial Plan Retrieved from http://www.msp.wa.gov/wp-content/uploads/2016/10/Preliminary_Draft_MSP_Section_2.pdf as accessed on 4/12/2017.

Watanabe, S., Sato, K., & Ponganis, P. J. (2012). Activity Time Budget during Foraging Trips of Emperor Penguins. *PLOS ONE, 7*(11), e50357. doi: 10.1371/journal.pone.0050357.

Watanuki, Y., Kato, A., Naito, Y., Robertson, G., & Robinson, S. (1997). Diving and foraging behaviour of Adélie penguins in areas with and without fast sea-ice. [journal article]. *Polar Biology, 17*(4), 296-304. doi: 10.1007/pl00013371.

Watkins, W. A. (1985). Investigations of sperm whale acoustic behaviors in the southeast Caribbean. *Cetology, 49*, 1-15.

Watkins, W. A. (1986). Whale Reactions to Human Activities in Cape Cod Waters. *Marine Mammal Science, 2*(4), 251-262.

Watkins, W. A., & Moore, K. E. (1983). Three right whales (Eubalaena glacialis) alternating at the surface. *Journal of Mammalogy, 64*(3), 506-508.

Watkins, W. A., & Schevill, W. E. (1975). Sperm whales (*Physeter catodon*) react to pingers. *Deep Sea Research and Oceanographic Abstracts, 22*, 123-124.

WDFW. (2015). *Washington's State Wildlife Action Plan: 2015 Update.* Olympia, Washington: Washington Department of Fish and Wildlife.

Weitkamp, L., & Neely, K. (2002). Coho salmon (Oncorhynchus kisutch) ocean migration patterns: insight from marine coded-wire tag recoveries. *Canadian Journal of Fisheries and Aquatic Sciences, 59*(7), 1100-1115. doi: 10.1139/f02-075.

Welch, H. E., Crawford, R. E., & Hop, H. (1993). Occurrence of Arctic cod (Boreogadu saida) schools and their vulnerability to predation in the Canadian high Arctic. *Arctic, 46*(4), 331-339.

Weller, D. W., Bettridge, S., Brownell Jr, R. L., Laake, J. L., Moore, J. E., Rosel, P. E., . . . Wade, P. R. (2013). *Report of the National Marine Fisheries Service gray whale stock identification workshop*. (NOAA Technical Memo. NOAA-TM-NMFS-SWFSC-507).

Weller, D. W., Burdin, A. M., Würsig, B., Taylor, B. L., & Brownell, R. L., Jr. (2002). The western Pacific gray whale: a review of past exploitation, current status and potential threats. *Journal of Cetacean Research and Management, 4*(1), 7-12.

Weller, D. W., Klimek, A., Bradford, A. L., Calambokidis, J., Lang, A. R., Gisborne, B., . . . Brownell, R. L., Jr. (2012). Movements of gray whales between the western and eastern North Pacific. *Endangered Species Research, 18*(3), 193-199.

Weller, D. W., Würsig, B., Bradford, A. L., Burdin, A. M., Blokhin, S. A., Minakuchi, H., & Brownell, R. L., Jr. (1999). Gray whales (Eschrichtius robustus) off Sakhalin Island, Russia: seasonal and annual patterns of occurrence. *Marine Mammal Science, 15*, 1208-1227.

Wenz, G. M. (1962). Acoustic ambient noise in the ocean: Sources and spectra. *The Journal of the Acoustical Society of America, 34*(12), 1936-1956.

Wever, E. G., Herman, P. N., Simmons, J. A., & Hertzler, D. R. (1969). *Hearing in the Blackfooted Penguin, Spheniscus dermersus, as Represented by the Cochlear Potentials*. Auditory Research Laboratories, Princeton University.

Whitehead, H. (2002). Estimates of the current global population size and historical trajectory for sperm whales. *Marine Ecology Progress Series, 242*, 295-304.

Whitehead, H. (2003). *Sperm whales: Social evolution in the ocean*. In (pp. 431): University of Chicago Press.

Whitehead, H., & Arnbom, T. (1987). Social organization of sperm whale off the Galapagos Island, February-April 1985. *Canadian Journal of Zoology, 65*(4), 913-919.

Wiig, O., Bachmann, L., Janik, V. M., Kovacs, K. M., & Lydersen, C. (2007). Spitsbergen bowhead whales revisited. *Marine mammal science, 23*(3), 688-693.

Wiig, Ø., Bachmann, L., Øien, N., Kovacs, K. M., & Lydersen, C. (2010). Observations of bowhead whales (Balaena mysticetus) in the Svalbard area 1940–2009. *Polar biology, 33*(7), 979-984.

Wiig, Ø., Heide-Jørgensen, M. P., Lindqvist, C., Laidre, K. L., Palsbøll, P. J., & Bachmann, L. (2011). Population estimates of mark and recaptured genotyped bowhead whales (Balaena mysticetus) in Disko Bay, West Greenland. *Reports of the International Whaling Commission*.

Wilcock, J. A., Frank, I. S., Bednarski, J. A., & Jensen, K. A. (2011). *Contribution of Alaskan, Canadian, and Transboundary Sockeye Salmon Stocks to Catches in Southeast Alaska Purse Seine and Gillnet Fisheries, Districts 101–108, Based on Analysis of Scale Patterns, 2005*. Anchorage, Alaska: Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries. p. 42.

Wiley, D. N., Thompson, M., Pace, R. M., & Levenson, J. (2011). Modeling speed restrictions to mitigate lethal collisions between ships and whales in the Stellwagen Bank National Marine Sanctuary, USA. *Biological Conservation, 144*(9), 2377-2381.

Williams, G. D., Levin, P. S., & Palsson, W. A. (2010). Rockfish in Puget Sound: An ecological history of exploitation. *Marine Policy, 34*(5), 1010-1020. doi: http://dx.doi.org/10.1016/j.marpol.2010.02.008.

Williams, M. T., Nations, C. S., Smith, T. G., Moulton, V. D., & Perham, C. J. (2006). Ringed seal (Phoca hispida) use of subnivean structures in the Alaskan Beaufort Sea during development of an oil production facility. *Aquatic Mammals, 32*(3), 311.

Williams, R., Bain, D. E., Ford, J. K. B., & Trites, A. W. (2002). Behavioural responses of male killer whales to a "leapfrogging" vessel. *Journal of Cetacean Research and Management, 4*(3), 305-310.

Williams, R., Bain, D. E., Smith, J. C., & Lusseau, D. (2009). Effects of vessels on behaviour patterns of individual southern resident killer whales Orcinus orca. *Endangered Species Research, 6*(3), 199-209.

Williams, R., Erbe, C., Ashe, E., Beerman, A., & Smith, J. (2014). Severity of Killer Whale Behavioral Responses to Ship Noise: A Dose-Response Study. *Marine Pollution Bulletin, 79*, 254-260.

Williams, R., Wright, A. J., Ashe, E., Blight, L. K., Bruintjes, R., Canessa, R., . . . Wale, M. A. (2015). Impacts of anthropogenic noise on marine life: Publication patterns, new discoveries, and future directions in research and management. *Ocean and Coastal Management, 115*, 17-24.

Wilson, C. (2014, September 2002). Giant Kelp (*Macrocystis pyrifera*) Retrieved Retrieved September 2002from http://www.dfg.ca.gov/mlpa/response/kelp.pdf

Wilson, D. E., Bogan, M. A., Brownell Jr, R. L., Burdin, A. M., & Maminov, M. (1991). Geographic variation in sea otters, Enhydra lutris. *Journal of Mammalogy, 72*(1), 22-36.

Winfree, M. (2005). *Preliminary Aerial Reconnaissance Surveys of Eelgrass Beds on Togiak National Wildlife Refuge, Alaska, 2004*. Togiak National Wildlife Refuge. p. 10.

Woehler, E. J. (2004). Hearing abilities in Antarctic penguins. *Polarforschung, 72*(2/3), 95-98.

Wolfe, R. J. (2004). *Local Tranditions and Subsistence: A Synopsis from Twenty-Five Years of Research by the State of Alaska*. (Technical Paper No. 284). Juneau, Alaska: Alaska Department of Fish and Game, Division of Subsistence,.

Woodby, D. A., & Botkin, D. B. (1993). Stock sizes prior to commercial whaling. *The bowhead whale. Soc. Mar. Mammal., Spec. Publ*(2), 387-407.

Woodgate, R. (2013). Arctic Ocean Circulation: Going Around At the Top Of the World. *Nature Education Knowledge, 4*(8), 8.

Woodgate, R. A., Aagaard, K., & Weingartner, T. J. (2005). Monthly temperature, salinity, and transport variability of the Bering Strait through flow. *Geophys. Res. Lett., 32*(4). doi: 10.1029/2004GL021880.

Woods Hole Oceanographic Institution. (2006). Arctic Ocean Circulation Retrieved from http://polardiscovery.whoi.edu/arctic/circulation.html

Wright, D. L. (2015). *Simultaneous identification of four mysticete species in the Bering Sea using passive acoustic monitoring increases confidence in acoustic identification of the critically endangered North Pacific right whale (Eubalaena japonica)*. the International Fund for Animal Welfare. p. 63 pp.

Wyllie-Echeverria, S., & Ackerman, J. D. (2003). The seagrasses of the Pacific coast of North America. In. Green, E. P. & Short, F. T. (Eds.), *World Atlas of Seagrasses* (pp. 199-206). Berkeley, California: University of California Press.

Wyllie-Echeverria, T., & Wooster, W. S. (1998). Year-to-year variations in Bering Sea ice cover and some consequences for fish distributions. *Fisheries Oceanography, 7*(2), 159-170.

Yeung, C., & McConnaughey, R. A. (2006). Community structure of eastern Bering Sea epibenthic invertebrates from summer bottom-trawl surveys 1982 to 2002. *Marine Ecology Progress Series, 318*, 47-63.

Ylikoski, M. E., Pekkarinen, J. O., Starck, J. P., Paakkkonen, R. J., & Ylikoski, J. S. (1995). Physical characteristics of gunfire impulse noise and its attenuation by hearing protectors. *Scandinavian audiology, 24*(1), 3-11.

Yoda, K., Naito, Y., Sato, K., Takahashi, A., Nishikawa, J., Ropert-Coudert, Y., . . . Le Maho, Y. (2001). A new technique for monitoring the behaviour of free-ranging Adelie penguins. *Journal of Experimental Biology, 204*(4), 685.

Young, R. W. (1973). Sound Pressure in Water from a Source in Air and Vice Versa. *Journal of the Acoustical Society of America, 53*, 1708-1716.

Yuen, M. M. L., Nachtigall, P. E., Breese, M., & Supin, A. Y. (2005). Behavioral and auditory evoked potential audiograms of a false killer whale (Pseudorca crassidens). *The Journal of the Acoustical Society of America, 118*(4), 2688-2695.

Zemsky, V., & Sazhinov, E. (1994). Distribution and abundance of the pygmy blue whale. *Translated by VS Gurevich, edited by MA Donahue and RL Brownell Jr., National Marine Fisheries Service, Southwest Fisheries Science Center, Administrative Report LJ-94-02*, 1-17.

Zenkovich, B. (1938). On the grampus or killer whale (Grampus orca Lin.). *Priroda, 4*, 109-112.

Zerbini, A. N., Waite, J. M., Laake, J. L., & Wade, P. R. (2006). Abundance, trends and distribution of baleen whales off Western Alaska and the central Aleutian Islands. *Deep Sea Research Part I: Oceanographic Research Papers, 53*(11), 1772-1790.

Zier, J., & Gaydos, J. K. (2016, April 13-15 2016). *The growing number of species of concern in the Salish Sea suggests ecosystem decay is outpacing recovery.* Paper presented at the 2016 Salish Sea Ecosystem Conference, Vancouver, BC.

APPENDIX A SPECIES WHOSE RANGE OVERLAPS WITH POTENTIAL TRANSITING AREAS

The following are the list of species whose range overlaps with potential transiting areas (for Birds [Table A-1] and Sea Turtles [Table A-2] it is ESA-listed only; for mammals [Table A-3] it is the entire list that could be in the proposed action areas and in transit). The evaluation of impacts from Acoustic Transmissions (see Section 4.1.2), Vessel Noise (see Section 4.1.3), and Vessel Movement (see Section 4.2.1) would also be applicable to the species below, in particular for marine mammals and the risk of a collision with the vessel while in transit. Conclusions for each species are similar to the conclusions provided in the previous sections, as appropriate for each group/species below.

A.1 BIRDS

Table A-1. ESA-Listed Threatened or Endangered Birds Expected during Vessel Transit

Common Name	Scientific Name	Status	Order
Rufa red knot	*Calidris canutus rufa*	Threatened	Charadriiformes
Newell's Townsend's shearwater	*Puffinus auricularis newelli*	Threatened	Procellariiformes
Band-rumped storm-petrel	*Oceanodroma castro*	Endangered[1]	Procellariiformes
Roseate tern	*Sterna dougallii dougallii*	Endangered/Threatened[2]	
Bermuda petrel	*Pterodroma cahow*	Endangered	Procellariiformes
Hawaiian petrel	*Pterodroma sandwichensis*	Endangered	Procellariiformes
Andrew's frigatebird	*Fregata andrewsi*	Endangered	Pelecaniformes
Chatham Island petrel	*Pterodroma axillaris*	Endangered	Procellariiformes
Magenta petrel	*Pterodroma magentae*	Endangered	Procellariiformes
Galapagos petrel	*Pterodroma phaeopygia*	Threatened	Procellariiformes
Southern rockhopper penguin	*Eudyptes chrysocome*	Threatened	Sphenisciformes
Fiordland crested penguin	*Eudyptes pachyrhynchus*	Threatened	Sphenisciformes
Erect-crested penguin	*Eudyptes sclateri*	Threatened	Sphenisciformes
White-flippered penguin	*Eudyptula albosignata*	Threatened	Sphenisciformes
Humboldt penguin	*Spheniscus humboldti*	Threatened	Sphenisciformes
Galapagos penguin	*Spheniscus mendiculus*	Endangered	Sphenisciformes
Yellow-eyed penguin	*Megadyptes antipodes*	Threatened	Sphenisciformes

[1] Hawaii distinct population segment only.
[2] The roseate tern is listed as endangered under the ESA along the Atlantic coast south to North Carolina, Canada (Newfoundland, Nova Scotia, Quebec), and Bermuda. It is listed as threatened under the ESA in the Western Hemisphere and adjacent oceans, including Florida, Puerto Rico, and the Virgin Islands

A.2 Sea Turtles

Table A-2. ESA-Listed Threatened or Endangered Sea Turtles Expected during Vessel Transit

Common Name	Scientific Name	Status
Green turtle	*Chelonia mydas*	Threatened/Endangered[1]
Loggerhead turtle	*Caretta caretta*	Threatened/Endangered[2]
Hawksbill turtle	*Eretmochelys imbricata*	Endangered
Kemp's ridley turtle	*Lepidochelys kempii*	Endangered
Olive ridley turtle	*Lepidochelys olivacea*	Endangered/Threatened[3]

[1,2] Threatened or Endangered depending on the DPS. Potential transit areas include habitat for both types of listing.
[3] The Mexican Pacific coast breeding population is listed as endangered; elsewhere the species is listed as threatened.

A.3 Marine Mammals

All marine mammals in Table A-3 could overlap with vessels during transit. Those species that have "**Transit Only**" were not discussed in detail in Sections 3.2.7.4 (ESA-listed marine mammal species) or Section 3.2.7.5 (non-ESA-listed marine mammals species). However, vessel movement discussed in Section 4.2.1 and the environmental consequences would be applicable to these species, as well, specifically a collision between the marine mammals and the vessel. The Atlantic is identified because icebreaking will occur on the "Pacific side" of the Arctic Region so transit from Arctic to Pacific Northwest and then through Pacific routes are expected. An example transit route for an Antarctic mission could begin in Seattle, Washington; transit to Honolulu, Hawaii; to Hobart, Australia; to McMurdo Station, Antarctica; to Fiji; and return to Seattle, Washington. A transit through the Atlantic is outside of this route and different species/stocks would be expected.

Table A-3. Distribution of Marine Mammals, including Stocks and their Status Expected in the Arctic, Pacific Northwest, and Antarctic Proposed Action Areas and those Encountered during Vessel Transit Only

Common Name	Distribution/Seasonality	Stock(s) within the Action Areas for icebreaking and vessel movement (Arctic, Pacific Northwest (PNW), and Antarctic) or transit only	Status[1]
Cetaceans: Mysticetes			
Blue whale *(Balaenoptera musculus)*	Open-ocean, but do come close to shore to feed, and possibly mate/breed, in certain areas. Observed from tropical waters to pack ice edges in both hemispheres. Avoid equatorial waters. Overlaps in some areas with Pygmy blue whale.	Arctic: NA PNW: ENP stock Antarctic: Present Atlantic: **Transit Only** Western North Atlantic	Global: Endangered CITES: App I IUCN: EN A1 adb[2]
Bowhead whale *(Balaena mysticetus)*	Found only in Arctic and subarctic generally between 55^{0}N and 85^{0}N. Found near sea ice, migrate to high arctic mostly summer and retreat southward in fall with advancing ice edge.	Arctic: Western Arctic stock PNW: NA Antarctic: NA	Global: Endangered CITES: App I IUCN: EN
Bryde's whale *(Balaenoptera edeni)*	Circumpolar, found in Atlantic, Pacific, and Indian oceans. Inhabits waters that area bout 16^{0}C. Rarely move poleward of 40^0 in either hemisphere.	**Transit Only**	CITES: App I IUCN: DD
Fin whale *(Balaenoptera physalus)*	Cosmopolitan, inhabiting oceanic waters of both hemispheres. Typically, if observed near shore, it's in the deep water as it approaches the coast. General poleward shift for feeding in summer and towards tropics for breeding in winter. Some resident groups are also observed.	Arctic: Northeast Pacific stock PNW: CA/OR/WA stock Antarctic: Possible Presence, likely **Transit Only**	Global: Endangered CITES: App I IUCN: EN A1d[2]

Gray whale (*Eschrichtius robustus)*	Only found in the Northern Hemisphere. Restricted to shallow continental shelf waters for feeding and live most of their lives within a few tens of kilometers of shore. The WNP stock ranges from coast of southern China to the Sea of Okhotsk. The ENP stock can be found in the Arctic-mainly in summer and migrate from the Arctic to the lagoons in Mexico and back to the Arctic from October to June. A proportion of the WNP also makes this migration. The PCFG gray whales are year-round (does not migrate northward in spring).	Arctic and PNW: WNP Stock; ENP stock PNW: also PCFG Antarctic: NA	WNP DPS-Endangered CITES: App I IUCN: LC
Humpback whale (*Megaptera novaeangliae)*	Cosmopolitan and only places where they are clearly absent are in some equatorial regions, a few enclosed seas, and some parts of the high Arctic. Migrate from wintering grounds in the tropics to temperate and polar summering grounds, reaching ice edge in both hemispheres.	Northern Hemisphere: WNP stock; CNP stock PNW: CA/OR/WA stock Southern Hemisphere: Antarctic: Present	WNP DPS and Central America DPS-Endangered Mexico DPS-Threatened CITES: App I IUCN: LC
Minke whale (Common) *(Balaenoptera acutorostrata)*	Widely distributed from tropics to subtropics to ice edges in both hemispheres. Specific distribution in Southern Hemisphere is not well-known. Some migrate from high latitude summer feeding grounds to lower latitude winter breeding areas.	Arctic: Common minke whale, Alaska stock PNW: Common minke whale; CA/OR/WA stock Antarctic: NA	CITES: App I and II (location dependent) IUCN: LC
Minke whale (Antarctic) *(Balaenoptera bonaerensis)*	Occur widely in coastal and offshore areas of the Southern Hemisphere. Found from at least 7^{0}S to the ice edges. Not all migrate, but there is a general shift northward to breed in winter and most spend summer in waters of Antarctic continent (some overwinter there).	Arctic: NA PNW: NA Antarctic: Present	CITES: App I IUCN: DD
North Atlantic right whale (*Eubalaena glacialis*)	Small population. Distribution strongly correlated with prey. Winter they occur in lower latitudes and coastal waters where calving takes place; summer in feeding grounds in New England to Scotian Shelf.	Atlantic: **Transit Only**	Global: Endangered; Critical Habitat (59 FR 28805 and 81 FR 4837) CITES: App I IUCN: EN

North Pacific right whale (*Eubalaena japonica)*	Extremely rare in North Pacific; reliably observed in southeastern Bering Sea shelf in April to September. Few sightings observed off of U.S. west coast. Critical habitat is in Gulf of Alaska/Bering Sea. Not found in Antarctica.	Arctic and PNW: ENP stock Antarctic: NA	Global: Endangered; Critical Habitat (71 FR 38277) CITES: App I IUCN: EN
Pygmy blue whale (*B. m. brevicauda*)	Not completely known, but occurs in Southern Hemisphere. In Antarctic, prefers more northern waters than true blue whale.	**Transit Only**	IUCN: DD
Pygmy right whale (*Caperea marginata*)	Circumpolar in coastal and oceanic waters; between ~30S and 55S (north of Antarctic Convergence); no large scale migrations anticipated	**Transit Only**	CITES: App I IUCN: DD
Sei whale (*Balaenoptera borealis)*	Not often seen near coast; occur from the tropics to polar zones in both hemispheres. More restricted to mid-latitude temperate zone. Undergo seasonal migrations. Largely unpredictable patterns.	Arctic: NA PNW: ENP stock Antarctic: Possible Presence	Global: Endangered CITES: App I IUCN: EN
Southern right whale (*Eubalaena australis)*	Circumpolar distribution in Southern Hemisphere, from ~20S to 55N, but have been observed as far south as 65S. Move south in summer to feed; migrate north in winter and concentrated near coastlines. A few have been sighted in Antarctic waters in summer.	**Transit Only**	CITES: App I IUCN: LC
Cetaceans: Odontocetes			
Andrew's beaked whale (*Mesoplodon bowdoini*)	Only known from stranding records between 32^0S and 55^0S; range may be circumpolar in Southern Hemisphere. Presumably prefers deeper waters.	**Transit Only**	CITES: App II IUCN: DD
Arnoux's beaked whale (*Berardius arnuxii)*	Believed that they have a vast circumpolar distribution in deep, cold, temperature and subpolar waters of the Southern Hemisphere. Most records are south of 40^0S, but there are some records as far north as 24^0S.	Arctic: NA PNW: NA Antarctic: Present	CITES: App I IUCN: DD
Atlantic spotted dolphin (*Stenella frontalis*)	Only found in Atlantic Ocean from southern Brazil to New England and cost of Africa. Typically in warm-temperate waters over the continental shelf and upper continental slope. May inhabit deeper waters.	Transit Only (Atlantic side only)	CITES: App II IUCN: DD

Beluga whale (*Delphinapterus leucas)*	Almost panarctic, found only in high latitudes of Northern Hemisphere (from 50-80^{0}N), from west coast of Greenland, west to eastern Scandinavia and Svalbard. Occur seasonally (in summer) in coastal, shallow, waters, but also occur in deep, offshore, waters. Enter estuaries and sometimes rivers.	Arctic: Beaufort Sea stock, Eastern Chukchi Sea stock; Transit Only: Eastern Bering Sea stock, Bristol Bay stock PNW: NA Antarctic: NA	Cook Inlet DPS-Endangered Critical Habitat for CI Beluga (76 FR 20180) CITES: App II IUCN: NT
Baird's beaked whale (*Berardius bairdii)*	Found in deep oceanic waters of North Pacific Ocean, and the Japan, Okhotsk, and Bering Seas. Range extends to southern Gulf of California and island of Kysuha, Japan. Primarily over or near the continental slope, may occur in the vicinity of drift ice, and migrate into waters over the continental slope from May to October. Winter distribution is unknown.	Arctic: Alaska stock PNW: CA/OR/WA stock Antarctic: NA	CITES: App II IUCN: DD
Blainville's beaked whale (*Mesoplodon densirostris)*	In temperate and tropical waters of all oceans. Found mostly offshore in deep waters and occur in many enclosed seas with deep water	PNW: Possible Presence **Transit Only**	CITES: App II IUCN: DD
Bottlenose dolphin (*Tursiops truncatus*)	Very widely distributed, found most commonly in coastal and continental shelf waters of the tropical and temperate regions of the world. Frequent bays, lagoons, channels, and mouths of rivers, but can also be found in deep waters. They typically do not range poleward of 45^0 in either hemisphere.	Arctic: NA PNW: CA/OR/WA stock Antarctic: NA Atlantic: Transit only Western North Atlantic offshore stock	CITES: App II IUCN: LC
Clymene dolphin (*Stenella clymene*)	Tropical and subtropical Atlantic Ocean, including the Caribbean Sea and Gulf of Mexico; with a notable warm water preference. Ranges as far north as New Jersey to Brazil and to west coast of Africa. A deep water species and not known to approach near shore unless deep water is present.	Atlantic: **Transit Only**	CITES: App II IUCN: DD
Cuvier's beaked whale (*Ziphius cavirostris)*	Widely distributed in offshore waters of all oceans, from tropics to polar regions in both hemispheres. Range covers global marine waters, with the exception of shallow waters and very high-latitude polar regions. Found in deep waters (>200 m), but prefer waters over and near the continental slope.	Arctic: Alaska stock PNW: CA/OR/WA stock Antarctic: NA **Transit Only**: Western North Atlantic stock; at/near Antarctic Peninsula	CITES: App II IUCN: LC

Dall's porpoise (*Phocoenoides dalli)*	Found only in North Pacific Ocean and Bering, Okhotsk, and Japan seas. Inhabit deep waters of the warm temperate through subarctic zones, between 30⁰N and 62⁰N. During unusual cold periods, range may extend as far south as 28⁰N. Occur far offshore in oceanic zones, but approach nearshore where deep water approaches coast. Commonly seen in inshore waters of Washington, British Columbia, and Alaska.	Arctic: Alaska stock PNW: CA/OR/WA stock Antarctic: NA	CITES: App II IUCN: LC
Dwarf sperm whale (*Kogia sima*)	Distributed widely in tropical to warm temperate zones, largely offshore.	PNW: Possible Presence, likely Transit Only	CITES: App II IUCN: DD
False killer whale (*Pseudorca crassidens*)	Tropical to warm temperate zones, generally in deep, offshore waters of the three major oceans. Do not range poleward of 50⁰ in either hemisphere.	**Transit Only**	Endangered (Main Hawaiian Island Insular) CITES: App II IUCN: DD
Fraser's dolphin (*Lagenodelphis hosei*)	Pantropical distribution, between 30⁰N and 30⁰S. An oceanic species that prefers deep offshore waters, can be seen nearshore if water is deep/	**Transit Only**	CITES: App II IUCN: LC
Gervais' beaked whale (*Mesoplodon europaeus*)	Species is probably continuously distributed in deep waters across the tropical and temperate Atlantic Ocean, north and south of the equator. Southern Hemisphere distribution may extend to Uruguay and Angola.	Atlantic: **Transit Only**	CITES: App II IUCN: DD
Gray's beaked whale (*Mesoplodon grayi*)	Primarily in Southern Hemisphere occurring in circumantarctic, in deep water beyond the edge of the continental shelf, most records are south of 30⁰S. Observed in Antarctic in summer months, near Antarctic Peninsula and along the shores of the continent (among the sea ice).	**Transit Only**	CITES: App II IUCN: DD
Ginkgo-toothed whale (*Mesoplodon ginkgodens*)	In temperate and topical waters of the Indo-Pacific Ocean, from Sri Lanka, east to the shores of North America and the Galapagos Islands. Range is hypothesized (from stranding/sighting records) to be continuous across the Pacific and at least to Indian Ocean.	**Transit Only**	CITES: App II IUCN: DD

Harbor porpoise (*Phocoena phocoena)*	Found in cool temperate to subpolar waters of the Northern Hemisphere, in shallow waters, most often near shore. May occasionally travel over deeper shore waters. Range from central California and northern Honshu, Japan, to the southern Beaufort and Chukchi seas. In the Atlantic, they are found from the southeastern United States to southern Baffin Island. Also occur south and west of Greenland, Iceland, and Faroe Islands, and Baltic Sea.	Arctic: Bering Sea stock PNW: Northern Oregon/Washington Coast stock; Washington Inland Waters stock Antarctic: NA **Transit Only**: Gulf of Alaska stock, Southeast Alaska stock	CITES: App II IUCN: LC
Hector's beaked whale (*Mesoplodon hectori*)	Southern Hemisphere only, in cool temperate waters. Hypothesized (from stranding/sighting records) that this species has a continuous distribution in the Atlantic and Indian Ocean to at least South America to New Zealand.	**Transit Only**	CITES: App II IUCN: DD
Hourglass dolphin (*Lagenorhynchus cruciger)*	Circumpolar in higher latitudes of the southern oceans; range to the ice edges in the south, but northern limits are not well known (found at least 45^0S, but some reach 33^0S and most southerly sighting was near 68^0S). Only small dolphin regularly observed south of Antarctic Convergence.	**Transit Only**	CITES: App II IUCN: LC
Hubb's beaked whale (*Mesoplodon carlhubbsi)*	Limited to North Pacific Ocean, from central British Columbia o southern California in the east, and Japan in the west. Sightings have been made off of Oregon, USA.	PNW: Possible Presence Transit Only	CITES: App II IUCN: DD
Killer whale (*Orcinus orca)*	Most cosmopolitan of all cetaceans; can be seen in any marine region, from equator to ice edges and occur in many enclosed seas. Generally more common in nearshore areas and at higher latitudes. Type A are found in all oceans and seas, from ice edges to more common nearshore, cool temperate to subpolar waters; Type B are found mainly in Antarctic and surrounding waters, often in pack ice (mainly near Antarctic Peninsula); Type C are also an Antarctic form, but prefer East Antarctica, mainly in pack ice.	Arctic: AK (resident); At1 Transient; Gulf of AK, Aleutian Islands, Bering Sea Transient PNW: Northern (resident); Southern (resident); Offshore (resident); West Coast Transient; Antarctic: Type A, mainly B and C	PNW: Southern Resident- Endangered; Critical Habitat for Southern Resident (71 FR 69054) CITES: App II IUCN: DD
Long-finned pilot whale (*Globicephala melas)*	In temperate and subpolar zones. Found in oceanic waters and some coastal waters of North Atlantic Ocean. Often found over the continental slope in winter and spring months and move over the shelf in summer and fall. Circumantarctic population in Southern Hemisphere may occur as far south as the Antarctic Convergence, to 68^0S.	**Transit Only**	CITES: App II IUCN: DD

Longman's beaked whale (*Indopacetus pacificus*)	Tropical Pacific and Indian oceans, although distribution is not fully understood, appears limited to the Indo-Pacific region. May prefer surface temperature waters of 21-31^{0}C, and may be more common in western Pacific and near the Maldives archipelago.	**Transit Only**	CITES: App II IUCN: DD
Melon-headed whale (*Peponocephala electra*)	Tropical/subtropical oceanic waters between 40^{0}N and 35^{0}S; rarely found nearshore unless water is deep.	**Transit Only**	CITES: App II IUCN: LC
Narwhal (*Monodon Monoceros)*	Found mostly above the Arctic Circle year-round. Inhabit the Atlantic sector of the Arctic, although there are a few records on the Pacific side. Found from central Canadian Arctic, eastward to Greenland in the eastern Russian Arctic (~180^{0}W). Annual migrations to open waters in spring and in summer follow the ice to more coastal areas. In winter remain in pack ice.	Arctic: Unidentified stock PNW: NA Antarctic: NA	CITES: App II IUCN: NT
Northern right whale dolphin (*Lissodelphis borealis)*	Oceanic, inhabiting cool and warm temperate regions of the North Pacific only, between 30^{0}N and 50^{0}N. There are some records from along the Aleutian Islands and Gulf of Alaska. Typically in deeper waters from outer continental shelf to oceanic regions.	Arctic: NA PNW: CA/OR/WA stock Antarctic: NA	CITES: App II IUCN: LC
Pacific white-sided dolphin (*Lagenorhynchus obliquidens)*	Inhabit cool temperate waters of the North Pacific and some adjacent seas (sea of Japan, Okhotsk, southern Bering and southern Gulf of California). Widely distributed in deep offshore waters, extend onto continental shelf, and in some areas very near shore. Occur in some inshore waters of the Pacific Northwest USA (e.g., Washington). Seasonal inshore/offshore and north/south movements documented.	Arctic: North Pacific stock PNW: CA/OR/WA, Northern and Southern stocks Antarctic: NA	CITES: App II IUCN: LC
Pantropical spotted dolphin (*Stenella attenuata*)	Found in Pacific, Atlantic, and Indian oceans, between 40^{0}N and 40^{0}S. Mainly in offshore tropical zones, but can occur close to shore in some areas where deep water approaches coastline.	**Transit Only**	CITES: App II IUCN: LC
Pygmy killer whale (*Feresa atenuata*)	Tropical/subtropical inhabiting oceanic waters around the globe, generally no ranging north of 40^{0}N or south of 35^{0}S; not seen neashore, but may occur near shore if water is deep.	**Transit Only**	CITES: App II IUCN: DD
Pygmy sperm whale (*Kogia breviceps)*	Deep waters in tropical to warm temperate zones of all oceans.	**Transit Only**	CITES: App II IUCN: DD
Risso's dolphin (*Grampus griseus)*	Widely distributed, inhabiting deep waters of continental slope and outer shelf from tropics to temperate regions in both hemispheres.	Arctic: NA PNW: CA/OR/WA stock Antarctic: NA Atlantic: Transit Only Western North Atlantic stock	CITES: App II IUCN: LC

Rough-toothed dolphin (*Steno bredanensis*)	Tropical to subtropical, generally inhabits deep, oceanic waters of all three major oceans, rarely ranging north of 40^0N or south of 35^0S.	**Transit Only**	CITES: App II IUCN: LC
Short-beaked common dolphin (*Delphinus delphis)*	Oceanic species widely distributed in tropical to cool temperate waters of the Atlantic and Pacific. Occurs in nearshore waters to thousands of kilometers offshore. Has a strong preference for upwelling-modified waters and areas with steep sea bottoms.	Arctic: NA PNW: CA/OR/WA stock Antarctic: NA	CITES: App II IUCN: LC
Short-finned pilot whale (*Globicephalus macrorhynchus)*	Found in warm temperate to tropical waters, generally in deep offshore areas. Do not range north of 50^0N or south of 40^0S.	PNW: Oceanographic condition-dependent Otherwise: Transit Only	CITES: App II IUCN: DD
Spectacled porpoise (*Phocoena dioptrica*)	Although rarely seen at sea, records information suggests that this may be a circumpolar species in the subantarctic zone (water temps at least 1-10^0C); southernmost sighting was from $64^0$34'S.	**Transit Only**	CITES: App II IUCN: DD
Spinner dolphin (*Stenella longirostris*)	Pantropical, encompassing oceanic tropical and subtropical zones in both hemispheres; limits are 40^0N and 40^0S.	**Transit Only**	CITES: App II IUCN: DD
Southern bottlenose whale (*Hyperoodon planifrons)*	Circumpolar distribution in Southern Hemisphere, south of ~30^0S, with concentrations between 58^0S and 62^0S, in the Atlantic and eastern Indian Ocean regions in their range. Migrate to Antarctic water during the summer, ~120 km from ice edge and sometimes reach ice edge.	Arctic: NA PNW: NA Antarctic: Present	CITES: App II IUCN: LC
Southern right whale dolphin (*Lissodelphis peronii*)	Found in cool temperate to subantarctic waters of the Southern Hemisphere, between 30^0S and 65^0S. Southern limit is bounded by Antarctic Convergence. Oceanic species coming close to shore only in deepwater coastal areas.	**Transit Only**	CITES: App II IUCN: DD
Sperm whale (*Physeter microcephalus)*	Somewhat migratory, cosmopolitan from tropics to pack ice edges in both hemispheres. Large males tend to venture to the extreme northern and southern portions of the range (poleward of 40–50^0). Inhabit deep waters and includes semi-enclosed seas with deep entrances.	Arctic: North Pacific stock PNW: CA/OR/WA stock Antarctic: Possible Presence	Endangered CITES: App I IUCN: VU A1d[2]
Stejneger's beaked whale (*Mesoplodon stejnegeri)*	Found in continental slope and oceanic waters of the North Pacific Basin, from central California, north to Bering Sea, and south to Sea of Japan. Cold temperate, subarctic species. Species may migrate north in the summer, and is common in Alaskan waters.	Arctic: Alaska stock PNW: Possible Presence Antarctic: NA	CITES: App II IUCN: DD

Strapped toothed beaked whale[3] (*Mesoplodon layardii)*	Continuous distribution in colder waters in the Southern Hemisphere, between 35^{0}S and 60^0 S; occur mostly in deeper waters. Stranding records indicate some migration, but little is known.	**Transit Only**	CITES: App II IUCN: DD
Striped dolphin (*Stenella coeruleoalba)*	Widely distributed, in Atlantic, Pacific, and Indian Oceans and adjacent seas. Primarily a warm water species, limits are about 50^{0}N and 40^{0}S.	Arctic: NA PNW: CA/OR/WA stock Antarctic: NA **Transit Only:** Western North Atlantic stock	CITES: App II IUCN: LC
True's beaked whale (*Mesoplodon mirus*)	Disjunct antitropical distribution, in Northern Hemisphere and occur at least in the southern Indian and Atlantic Oceans. There may be two forms, a Northern and a Southern form based on this distribution.	Atlantic: **Transit Only**	CITES: App II IUCN: DD
Pinnipeds:Otarids			
Antarctic fur seal (*Arctocephalus gazella*)	Widely distributed in waters south and in some areas, slightly north, of the Antarctic Convergence. Most of the population breeds on South Georgia and Bird islands. Vagrants have been found at Mawson Station on the Antarctic Continent. Males haul out exclusively in the mid- to late summer on islands along the Antarctic Peninsula. Females arrive in November and pupping and breeding occurs from late November to late December.	**Transit Only**	CITES: App II IUCN: LC
California sea lion (*Zalophus californianus)*	Occurs in eastern North Pacific from Tres Marias Islands (Mexico), through Gulf of Mexico, around the end of Baja California and north to the Gulf of Alaska. Most rookeries are south of Point Conception, California. Pupping and breeding take place from May through July. Sea lions are found in waters over the continental shelf and slope and occupy several landfalls far offshore in deep oceanic areas. There is a post-breeding migration (mainly juveniles and sub/adult males) north from the major rookeries in the southern portion of its range to winter from Central California to Washington. Smaller numbers migrate farther to British Columbia and Gulf of Alaska. Frequent bays, harbors, river mouths, and often haul out on buoys, jetties, boat docks, and other manmade objects.	Arctic: NA PNW: U.S. stock Antarctic: NA	IUCN: LC

Northern fur seal (*Callorhinus ursinus)*	Widely distributed pelagic species in the waters of the North Pacific Ocean, Bering Sea, Sea of Okhotsk, and Sea of Japan. Range from Northern Baja California, Mexico north and offshore across the North Pacific to northern Honshu, Japan. Southern limit is ~35^{0}N. Majority of population breeds in Alaska on the Pribilof Islands, with a substantial number on the Commander Islands, and a few still use San Miguel Island, California; Bogoslof Island, Bering Sea; and Robben Island, Russia. Breeding on the Pribilofs occurs from mid-June through August (California is usually two weeks earlier than the median date at the Pribilofs).	Arctic and PNW: Eastern Pacific stock Antarctic: NA	IUCN: VU A2b[4]
Steller sea lion (*Eumetopias jubatus)*	Found from central California, north to the Aleutian Islands across and north to Bering Sea to Bering Strait; west along the Aleutian chain to Kamchatka, and south along the Kuril Islands to northern Japan, Sea of Japan, Korea, and Sea of Okhotsk. Usually found from coast to outer continental shelf and slope. Eastern US stock could also be encountered in transit between PNW and Arctic region. They breed in late spring and summer and pups are born from May through July.	Arctic: Western U.S. stock PNW: Eastern U.S. stock Antarctic: NA	Arctic: Western DPS-Endangered, Critical Habitat (58 FR 4569) IUCN: NT
Pinnipeds: Phocids			
Bearded seal (*Erignathus barbatus)*	Circumpolar distribution in the Arctic, generally south of 80^{0}N. Also found in subarctic in lower Bering Sea, Sea of Okhotsk to northern Japan, and western North Atlantic reaching Gulf of St. Lawrence. Pups born on pack ice from mid0March to early May; after breeding season, many seals migrate northward with retreating ice, returning south again as the ice advances in fall and winter.	Arctic: Alaska stock PNW: NA Antarctic: NA	Arctic: Threatened IUCN: LC
Crabeater seal (*Lobodon carcinophaga)*	Circumpolar in the Antarctic and tied to the seasonal fluctuations of the pack ice. Found up to the coast of Antarctica, as far south as McMurdo Sound, during late summer ice break-up. Pups are born from September to December with a peak in October.	Arctic: NA PNW: NA Antarctic: Present	IUCN: LC
Harbor seal (*Phoca vitulina)*	Confined to coastal areas of the Northern Hemisphere, from temperate to Polar regions. Five species are recognized. Found in coastal waters of continental shelf and slope, common in bays, rivers, estuaries, and intertidal areas. Essentially non-migratory. Mating takes place during the February to October breeding season and pupping occurs sometime between April and July. Breeding/pupping season is clinal and dependent on location (occurs earlier in southern areas of a given population's range).	Arctic: Alaska stock PNW: Oregon/Washington stock; Washington Inland stock Antarctic: NA	IUCN: LC

Harp seal (*Pagophilus groenlandicus*)	Widespread in the Arctic and North Atlantic oceans and adjacent areas from Hudson Bay and Baffin Island east to Russia. Live chiefly in pack ice, but can be found away from it in summer. Pup from late February to mid-March on pack ice; mating occurs from mid-to late March. Migration occurs after mating/breeding following the ice north in the summer to feed in the Arctic.	Atlantic: **Transit Only**	IUCN: LC
Hawaiian monk seal (*Monachus schauinslandi*)	Throughout northwestern chain of Hawaiian Islands from Nihoa to Kure Atoll. Regularly seen on main Hawaiian Islands, particularly on Kauai. Haul out on land and breed on beaches of san and coral, and rocky terraces. Breeding season lasts from late December to mid-August, and pups are born between March and June.	In vicinity of Hawaii: **Transit Only**	Endangered; Critical Habitat (80 FR 50925) CITES: App I IUCN: Endangered C2a(i)
Hooded seal (*Cystophora cristata*)	Found in Arctic Ocean, and high latitudes of North Atlantic; shift their distribution with seasonal fluctuations. Breed on pack ice in March and early April. Major pupping areas include: Gulf of St. Lawrence, north of Newfoundland and east of Labrador, Davis Strait, and near Jan Mayen.	Atlantic: **Transit Only**	IUCN: VU A3c
Leopard seal (*Hydrurga leptonyx*)	Widely distributed in cold Antarctic and subantarctic waters of the Southern Hemisphere (50^{0}S to 80^{0}S), from the coast of the continent north through the pack ice, and most subantarctic islands. Haul out on land, ice, but prefer ice floes nearshore. Pups are born on ice from early November to late December, but period may extend from early October to early January.	Arctic: NA PNW: NA Antarctic: Present	IUCN: LC
Northern elephant seal (*Mirounga angustirostris*)	Found in eastern and central North Pacific. Breeding takes place on offshore island and at mainland localities from central Baja California to northern California. Migrate twice a year, returning to breed from December to March and again to molt for several weeks (at different times depending on sex and age). Post-breeding and post-molt migrations take most seals north and west to oceanic areas of the North Pacific and Gulf of Alaska, twice a year. Pupping occurs from late December to March.	Arctic: NA PNW: California Breeding stock Antarctic: NA	IUCN: LC

Ribbon seal (*Histriophoca fasciata)*	Occurs in the Sea of Okhotsk, Japan Sea, western North Pacific, and from Bering Sea north through Chukchi Sea, east to 160^{0}W. Rarely seen in western Beaufort Sea. Inhabit the southern edge of the pack ice from winter to early summer; most are pelagic in the Bering Sea during the summer. Some may venture south of the Aleutian Islands in the summer when they are not typically associated with sea ice. They prefer sea ice from the continental slope seaward out over deeper oceanic areas; especially pack ice coverage 60-80% and do not like highly concentrated pack or areas of sheet ice coverage. Pups are born on ice floes from early April to early May.	Arctic: Alaska stock PNW: NA Antarctic: NA	IUCN: LC
Ringed seal (*Phoca hispida)*	Circumpolar distribution throughout the Arctic basin, Hudson Bay and Straits, and Bering, Okhotsk, and Baltic seas. Strongly correlated with pack and land-fast ice, and areas covered at least seasonally by ices. Nearly all ringed seals breed on fast ice; excavate lairs in snow, in pressure ridges, and other snow covered features. Pupping generally occurs from March through April.	Arctic: Alaska stock PNW: NA Antarctic: NA	Arctic: Proposed as Threatened, Critical Habitat proposed IUCN: LC
Ross Seal (*Ommatophoca rossi)*	Circumpolar distribution in the Antarctic; usually found in dense consolidated pack ice, but also found on ice floes in more open areas. Seals do migrate north out of the pack ice zone into open water to forage. Pups are born November to December, with a peak in mid-November.	Arctic: NA PNW: NA Antarctic: Present	IUCN: LC
Southern Elephant Seal (*Mirounga leonine)*	A nearly circumpolar distribution in the Southern Hemisphere. They do reach the Antarctic continent, and areas like Ross Island, they are most common north of the seasonally shifting pack ice, especially in subarctic waters where most rookeries and haulouts are located.	**Transit Only**	IUCN: LC
Spotted seal (*Phoca largha)*	Widespread in the Sea of Okhotsk and the Sea of Japan, and reach china in the northern Yellow Sea; Bering and Chukchi seas and range north into the Arctic Ocean north to about the end of the continental shelf, west to about 170^{0}E to MacKenzie River Delta, Canada. Inhabit southern edges of the pack ice from winter to early summer and in late summer and fall move to coastal areas including river mouths. Breed exclusively and haul out on sea ice, but do come ashore on beaches, sandbars, mudflats or rocky reefs. Breeding takes place on pack ice from January to mid-April; pups (peak numbers) are born mid-to late March.	Arctic: Alaska stock PNW: NA Antarctic: NA	IUCN: LC

Weddell seal (*Leptonychotes weddellii*)	Circumpolar and widespread in the Southern Hemisphere; occur on fast ice, right up to the Antarctic continent. Also occur offshore on pack ice north to the seasonally shifting limits of the Antarctic Convergence and are also present on subantarctic islands along the Antarctic Peninsula, that are seasonally ice free. Pups are born from September through November, but animals in the lower latitudes pup earlier than animals living at higher latitudes.	Arctic: NA PNW: NA Antarctic: Present	IUCN: LC
Pinnipeds: Odobenids			
Pacific walrus (*Odobenus rosmarus)*	Discontinuous circumpolar distribution in the Arctic and subarctic. Pacific subspecies is found in the Bering and Chukchi seas to the East Siberian Sea in the west and the Western Beaufort Sea in the east. The Atlantic subspecies occurs in numerous subpopulations from the Eastern Canadian Arctic and Hudson Bay to the Kara Sea. The Laptev walrus is isolated in the Laptev Sea north of central Russia. All are found in relatively shallow continental shelf areas, and rarely occur in deeper waters. Regularly haul out on sea ice, sandy beaches, and rocky shores. Breeding occurs in late winter, from January through March.	Arctic: Alaska stock PNW: NA Antarctic: NA	Candidate species to list as Threatened CITES: App III IUCN: VU A3c[5]
Carnivores: Mustelids			
Sea otter (*Enhydra lutris)*	Found in shallow, nearshore waters of the North Pacific Rim, from the southern Kuril Islands, north along the Kamchatka Peninsula, then east along the Aleutian Islands to the Alaskan Peninsula and Prince William Sound, and south to California. Although frequently observed on the water's surface, they can haul out onshore. Pupping occurs year-round, but peaks in April to June in Alaska, and December to February in California.	Arctic: Northern sea otter (Southcentral Alaska, Southeast Alaska, Southwest Alaska, and Washington stocks PNW: Southern sea otter (California stock) Antarctic: NA	Southwest Alaska DPS-Threatened Critical Habitat (Southwest Alaska DPS of the Northern sea otter 74 FR 51988) CITES: App I and II (dependent on location) IUCN: EN A2abe[6]

Carnivores: Ursids			
Polar bear (*Ursus maritimus)*	Circumpolar distribution in the Northern Hemisphere; southern limits fluctuate with ice cover (have been as far south as Pribilof Islands and Newfoundland/Labrador). Northernmost record is 88^0N; but generally associated with sea ice, even though observed swimming many kilometers away from land/ice. Mating occurs in April to June and in November to December; females excavate dens where cub(s) are born in December and January.	Alaska Southern Beaufort Sea stock, Alaska Chukchi/Bering Sea stock PNW: NA Arctic: NA	Threatened, Critical Habitat (75 FR 76086) CITES: App II IUCN: VU A3c[7]

APPENDIX B QUANTIFYING ACOUSTIC IMPACTS ON MARINE MAMMALS: METHODS AND ANALYTICAL APPROACH

B.1 INTRODUCTION

This appendix describes the methods used to quantify potential effects to marine mammals from icebreaking activities. Sea turtles were not assessed for icebreaking sound exposure as their geographic ranges do not overlap any a proposed icebreaking areas. Other biological resources, such as birds, fish, and invertebrates that may potentially overlap with the proposed icebreaking area were not analyzed using this method because the model was developed for marine mammals so these resources were analyzed using qualitative methods.

Marine mammals are difficult to observe in real time and have varied behaviors based on species, geographic location and time of year. Furthermore, field-based information on the effects of icebreaking on marine mammals is unavailable. Therefore, mathematical modeling was necessary to estimate the number of marine mammals that may be affected by icebreaking activities. The Navy has invested considerable effort and resources analyzing the potential impacts of underwater sound sources (i.e., impulsive and non-impulsive sources on marine mammals and sea turtles). The Navy has used the Navy Acoustic Effects Model (NAEMO) since 1997 to model acoustic impacts to marine mammals. NAEMO has been refined since 1997 and documented in many environmental assessments and impact statements developed for Navy exercises. NAEMO was developed based on published research, collaboration with subject matter experts, and the Center for Independent Experts, an external peer-review system under the purview of NMFS.

B.2 DATA INPUTS TO THE MODEL

To run NAEMO, the model uses specific information about environmental conditions and the best available marine mammal data and quantifies potential impacts to marine mammals. The model also incorporated information collected by Roth et al. (2013) on the sound signature of CGC HEALY icebreaker and the proposed duration and timing of icebreaking activities. Environmental data often includes information about bathymetry, seafloor composition (e.g., rock, sand), and factors that vary throughout the year such as wind speed and underwater sound speed profiles. Marine mammal data includes densities, group sizes, and dive profiles. Lastly, the details of an activity are included (e.g., location, rate of occurrence, and source characteristics). Each of these inputs in described in more detail below.

B.3 LOCATIONS

For the purposes of this analysis, the NAEMO model incorporated location-specific variables in order to create an accurate representation of the marine environment where icebreaking activities would be expected to occur. The exact location of these activities would vary depending on ice cover, mission requirements, time of year, etc. Therefore, representative modeling “areas” were generated (one for the Arctic and one for the Antarctic) to define a location used for modeling purposes. These representative modeling areas were selected because the location provided environmental conditions such as open water, the ice edge, and ice-covered areas where the icebreakers would be expected to occur. Although it is not known, at this time, the exact location of future icebreaking activities, these representative areas allow the model to assess impacts under conditions similar to those where the icebreaker would be expected to ice break. The Arctic modeling box was approximately 60 by 60 nm (Figure B-1), and the Antarctic modeling area extends approximately 113 nm from McMurdo Station (Figure B-2). Although the exact location of icebreaking may shift away from these representative areas that were used to model, the results are not expected to change significantly.

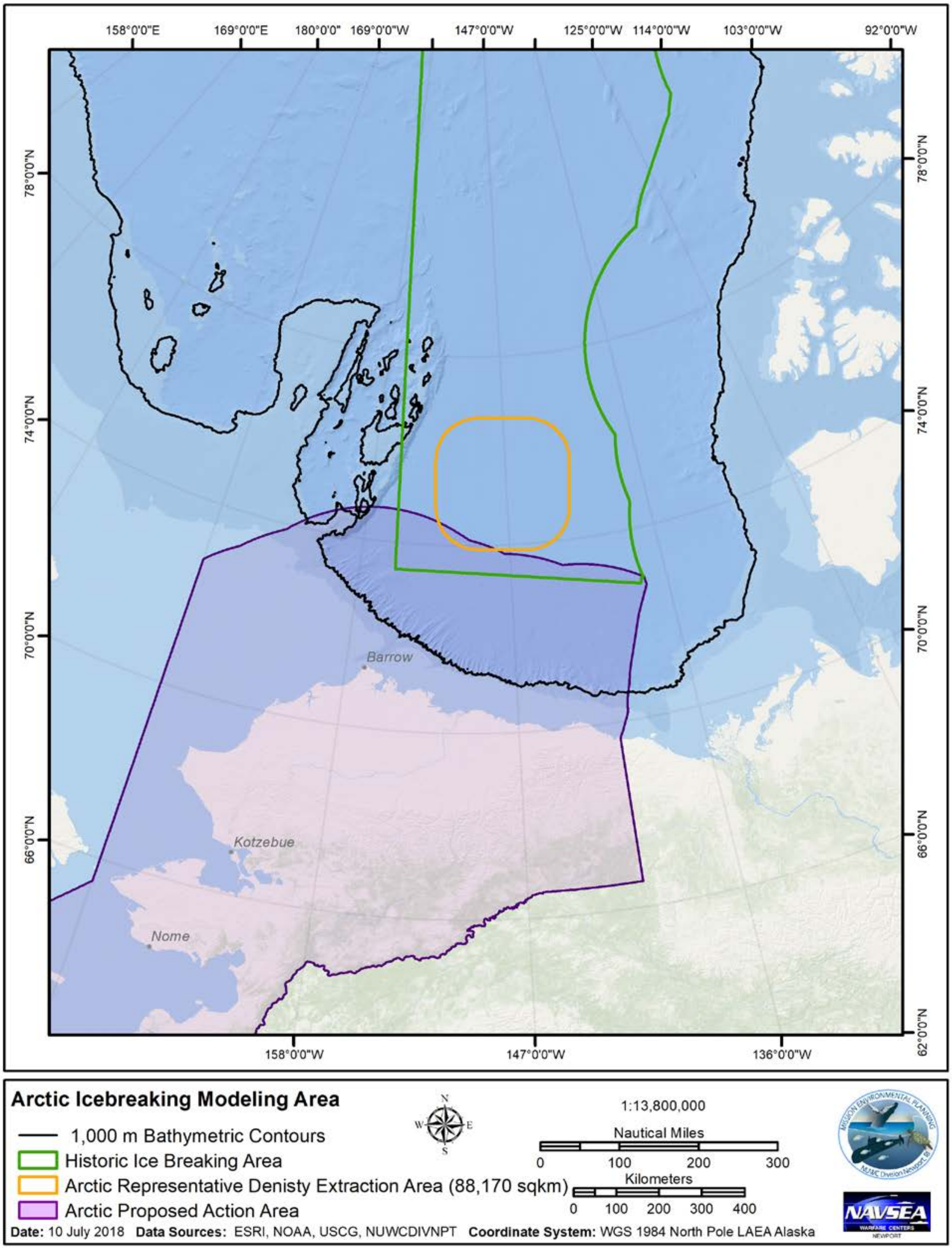

Figure B-1. Representative Modeling Box for the Arctic Proposed Action Area.

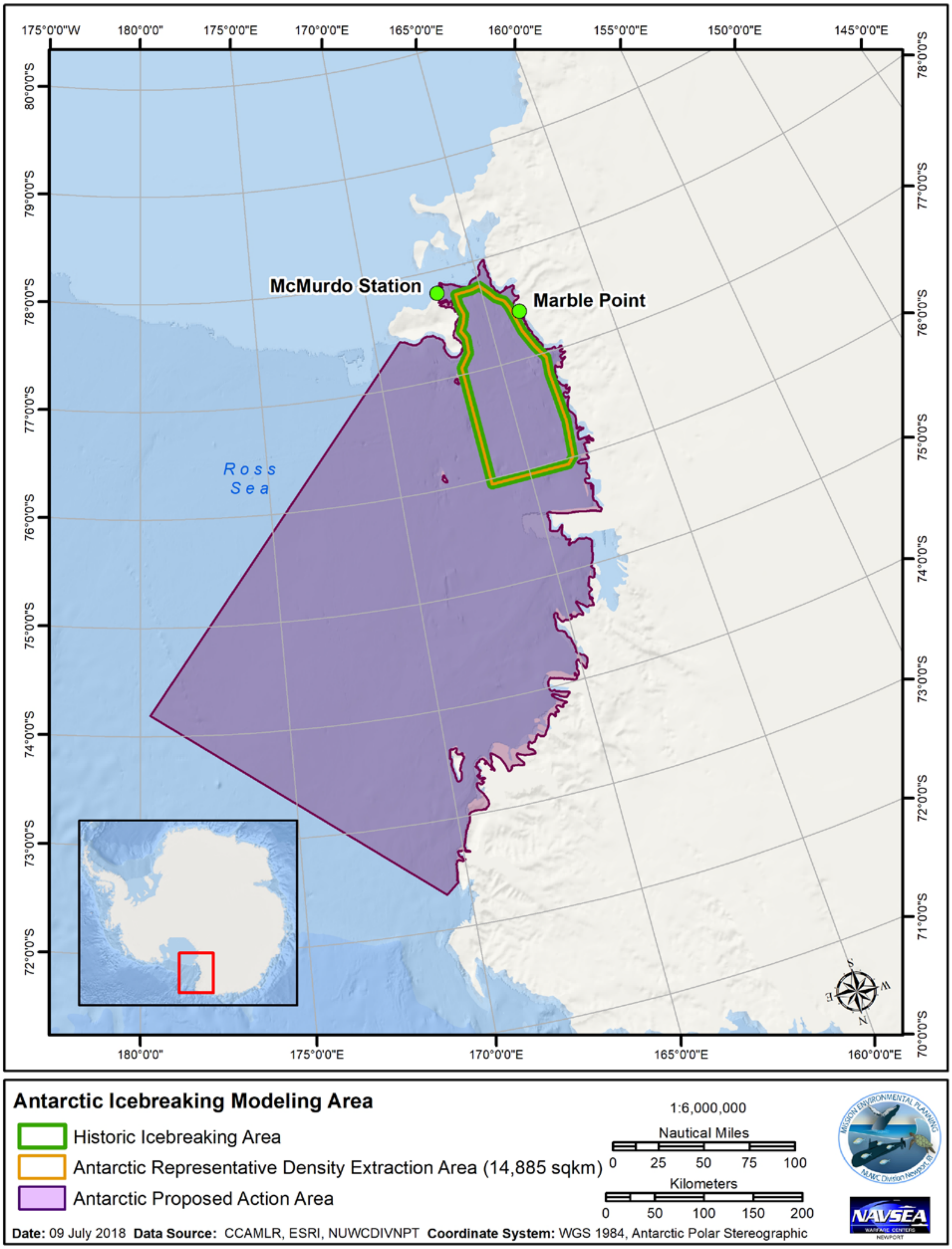

Figure B-2. Representative Modeling Box for the Antarctic Proposed Action Area.

B.4 Platforms

Only ice breakers were modeled as platforms as part of NAEMO, all other platforms associated with the Proposed Action had included non-modeled acoustic sources. Typical platform speed and depth are accounted for in NAEMO.

B.5 Activities and Events

Activities within NAEMO are further refined as "scenarios" which include data on the number of platforms, types and numbers of impulsive and non-impulsive sources, and source duration. Scenarios are then further defined as "events," which include details on location and frequency of occurrence. Section 4.1 provides additional information on how scenario and event definitions are implemented in NAEMO. In the NAEMO model, a scenario is what would happen in a 24-hour period. The event factors things such as hours or number of days. Thus, after a 24-hour period, the model resets.

B.6 Source Characteristics

B.6.1 Source Characteristics

Acoustic sources are divided into two categories, impulsive and non-impulsive. Impulsive sounds feature a rapid increase to high pressures, followed by a rapid return to static pressure. Impulsive sounds are often produced by processes involving a rapid release of energy or mechanical impacts (Hamernik and Hsueh 1991). Explosions and air gun impulses are examples of impulsive sound sources. Non-impulsive sound sources can be narrowband or tonal, brief or prolonged, continuous or intermittent, and lack the rapid rise time of impulsive sources. Ice breaking was considered a non-impulsive sound source. Non-impulsive sound sources include sonar and other transducers, which lack the rapid rise time of impulsive sources and can have durations longer than those of impulsive sounds can.

In addition to impulsive and non-impulsive, sources can be categorized as either broadband (producing sound over a wide frequency band) or narrowband (where the energy is within a single one-third octave band). Typically, broadband is equated with impulsive sources, and narrowband with non-impulsive sources, although non-impulsive broadband sources, such as acoustic communications equipment are also considered. Icebreaking was modeled as a non-impulsive broadband source. All non-impulsive sources were modeled using the geometric mean frequency. Only non-impulsive sources are discussed for the purposes of this analysis.

B.6.1.1 Non-Impulsive Sources

Non-impulsive sources are sonars and other transducers and include the following types of devices: submarine sonars, surface ship sonars, helicopter dipping sonars, torpedo sonars, active sonobuoys, countermeasures, underwater communications, tracking pingers, unmanned underwater vehicles and their associated sonars, and other devices.

The following terms were used to collect data on non-impulsive sources:

Source Depth – the depth at which a source goes active.

Source Level – the sound level of a source at a nominal distance of 1 m, expressed in decibels referenced to one micropascal (dB re 1 μPa).

Nominal Frequency – typically, the geometric mean of the frequency bandwidth.

Source Directivity – the source beam was modeled as a function of a horizontal and a vertical beam pattern.

The horizontal beam pattern was defined by two parameters:

Horizontal Beamwidth – the width of the source beam in degrees measured at the 3-decibel (dB) down points in the horizontal plane (assumed constant for all horizontal steer directions).

Relative Beam Angle – the direction in the horizontal plane that the beam was steered relative to the platform's heading (direction of motion) (typically 0°).

The vertical beam pattern was defined by two parameters:

Vertical Beamwidth – the width of the source beam in degrees in the vertical plane measured at the 3-dB down points (assumed constant for all vertical steer directions).

Depth/Elevation Angle – the vertical orientation angle relative to the horizontal.

Ping Interval – the time in seconds between the start of consecutive pulses for a non-impulsive source.

Pulse Length – the duration of a single non-impulsive pulse, specified in milliseconds. Duty cycle is defined as ping interval/ pulse length.

Signal Bandwidth –The geometric mean frequency is the square root of the product of the frequencies defining the frequency band (see equation 1)

$$f_{gm} = (f_{min} \times f_{max})^{0.5} \qquad (1)$$

where f_{max} is the upper cutoff frequency and f_{min} is the lower cutoff frequency.

Many of these system parameters are classified and cannot be provided in an unclassified document. Each source was modeled utilizing representative system parameters based on the non-impulsive source category within which it occurs.

Source Bins

Within NAEMO, non-impulsive sources are grouped into bins that are defined in accordance with their fundamental acoustic properties such as frequency, source level, beam pattern, and duty cycle. Each bin is characterized by the most conservative parameters for all sources within that bin. Specifically, bin characteristics for non-impulsive sources were selected based on (1) highest source level, (2) lowest geometric mean frequency, (3) highest duty cycle, and (4) largest horizontal and vertical beam patterns. Some sources are removed from quantitative analysis because they are not anticipated to result in takes of protected species include those of low source level, narrow beamwidth, downward-directed transmission, short pulse lengths, frequencies above known hearing ranges of marine mammals, or some combination of these factors.

The use of source classification bins provides the following benefits:

- provides the ability for new sensors or munitions to be covered under existing authorizations, as long as those sources fall within the parameters of a "bin"
- allows analysis to be conducted in a more efficient manner, without any compromise of analytical results
- simplifies the source utilization data collection and reporting requirements under Marine Mammal Protection Act authorizations if necessary
- ensures a conservative approach to all impact estimates, as all sources within a given class are modeled at the lowest frequency, highest source level, longest duty cycle, or largest net explosive weight within that bin
- provides a framework to support the reallocation of source usage (hours/explosives) between different source bins, as long as the total numbers of takes remain within the overall analyzed and authorized limits

B.7 PHYSICAL ENVIRONMENT

The physical environment data described below plays an important role in the acoustic propagation used in the modeling process. Some of these characteristics (e.g. temperature, salinity) cannot be forecast far enough into the future with sufficient accuracy for the purpose of this analysis (the first icebreaker is expected as soon as 2023). Furthermore, the exact timing of icebreaking activities associated with the Proposed Action is unknown. Therefore, the model used historical data to define a typical environmental state for the boreal (Arctic) and austral (Antarctic) summer, the period when icebreaking is most likely to occur in those respective areas. Information on bathymetry, seafloor composition, temperature, salinity, and pressure were obtained from the Oceanographic and Atmospheric Master Library (OAML), an aggregation of smaller databases of oceanographic data, and then incorporated into NAEMO. Table B-1 provides the environmental parameters used in NAEMO for the Proposed Action.

Bathymetry

Bathymetry can affect sound propagation in a variety of ways. In a shallower area, sound will have more interaction with the bottom which will absorb some of the sound energy than it would in a deeper area. Furthermore, the slope of the seafloor determines the angle at which sound will be reflected off the bottom. Bathymetry was obtained at the highest resolution available, ranging from 0.05–2.0 arc-minutes.

Seafloor Composition

Seafloor composition can affect acoustic propagation calculations. Acoustic propagation paths in deep water usually do not interact with the seafloor, whereas in shallow waters, the bottom-type could influence whether sounds are absorbed or reflected. For example, a muddy bottom absorbs more energy and a rocky bottom reflects more energy. The central regions of the northern Bering Sea are characterized by fine and very fine sand, with coarser grained sand, gravel, and cobbles near the outer boundaries of the northern Bering Sea and Bering Strait (Grebmeier et al. 1989; Logerwell et al. 2015). Sediments in the Chukchi Sea are characterized by more heterogeneous fine sand/silt and clay sediments. The Ross Sea's irregular topography is composed of various distributions of silt, sand, glacial till and gravel, biogenic material, and scattered boulders (Clarke 1996). In the deeper regions of the continental shelf (greater than approximately 984 ft [300 m]), where bottom circulation remains weak, siliceous biogenic ooze, silt, and clay make up the primarily soft sediment substrate, unlike in shallower regions where stronger currents and glacial outlets give way to rougher gravel and sand (Anderson et al. 1984).

Temperature, Salinity, and Pressure

Temperature, salinity, and pressure affect the speed with which sound travels through the water. These variables mostly change with depth in the, resulting in a sound speed "profile." Sound speed profile data were extracted from the OAML at the highest database resolution of 0.25 degree over the extent of the modeling areas.

Wind Speed

Wind speed data are typically extracted from the Surface Marine Gridded Climatology data at the highest available resolution of one degree. Wind speed data are directly related to other environmental parameters, primarily the sound speed. However, because the proposed icebreaking area is assumed to be covered in ice, this is not applicable for NAEMO modeling.

Seasonal Definitions

Coast Guard activities are not limited to a specific month or season. Therefore, a seasonal approach was adopted to meet this requirement, given the impracticality of modeling each scenario for every month. The seasonal definitions that were employed were dictated by region and marine mammal presence detailed in U.S. Navy (U.S. Navy 2014a). Seasons were defined as cold (December to May) or warm (June to November) in the Arctic and the opposite months of the year for the Antarctic. The seasonal averages were generated by linearly averaging the data for the months within a given season.

Table B-1. Environmental Parameters for Icebreaking in the Arctic and Antarctic

Model / Parameter	Data Input	Database
	Specific data are not applicable for this parameter.	Comprehensive Acoustic System Simulation Version 4.3b
Absorption Model	Specific data are not applicable for this parameter.	Francois-Garrison (the CASS/GRAB default)
Analysis Locations	Arctic representative modeling Area: lower left corner: 75.81, -149.26 upper right corner: 75.76, -145.20	Database not used for this parameter
Analysis Specifics	Artic representative area	Database not used for this parameter
Bathymetry	Data was obtained from representative location in the Arctic (defined above). Resolution was 500m.	The International Bathymetry Chart of the Arctic Ocean (IBCAO) Version 3.0
Sound Speed Profiles	Sound speed profiles were extracted at the highest database resolution 0.25 degree.	Generalized Digital Environmental Model Variable (GDEM-V) Version 3.0
Wind Speed	Not applicable since covered in ice	Surface Marine Gridded Climatology (SMGC) Version 2.0
Geo-Acoustic Parameters	Sediment type of medium sand was determined for the Arctic Area.	High Frequency Environmental Acoustics Version 2 HFEVA
Surface Reflection Coefficient Model	Specific data are not applicable for this parameter.	Navy Standard Forward Surface Loss Model

B.8 BIOLOGICAL ENVIRONMENT

In NAEMO, marine species are represented by “animats,” virtual animals used during modeling (Dean 1998). In order to simulate the behavior and spatial distribution of marine mammals, NAEMO requires data on their densities, group sizes, dive profiles, and body masses.

Marine Mammal Density

Information on species-specific distribution and abundance in the areas of interest is necessary to calculate the number of animals potentially affected by icebreaking activities. This information is most easily expressed as a density (e.g. number of animals per square kilometer), the number of animals of each species that may be present within a specific area and timeframe. Details on the density data and parameters input into NAEMO are provided in the Navy Marine Species Density Database (NMSDD) (U.S. Navy 2014a, 2017a, 2017b). Density estimates for the Arctic and Antarctic, for certain species were often scarce, particularly, in the location where icebreaking would be expected to occur. As much as possible, modeling relied on field-based density estimates in or at least near to the representative locations for icebreaking. These include the most recent surveys of the Ross Sea published by the International Whaling Commission (IWC), seal density estimates compiled by the New Zealand Antarctic Institute, as well as various published estimates of Arctic species densities (Table B-2). In cases where field-based density estimates did not exist, the model used densities from a Relative Environmental Suitability (RES) model (Kaschner et al. 2006). For some species RES densities could be compared to published field surveys conducted in the same general area as the representative location, for validation. It was assumed that although some of these field-based studies were conducted in locations in the Arctic and Antarctic, that the density estimate was the best available and representative for the appropriate modeling area in each proposed icebreaking location. For certain species, RES values were the only source of data. Therefore, in conjunction with NMSDD and when possible, densities were verified using published peer reviewed field surveys or published density models before input into the model.

Table B-2. Sources Used for Marine Mammal Density Estimates

Species	Source
Arctic	
Bearded Seal	Kaschner et al., 2006.
Beluga Whale	Harwood, 1996. Duval, 1993.
Killer Whale	Kaschner et al., 2006.
Ringed Seal	Bengston et al., 2005.
Bowhead Whale	Kaschner et al., 2006.
Narwhal	FAO Canada, 2013
Walrus	Kaschner et al., 2006.
Polar Bear	Taylor and Lee, 1995. Vongraven and Peacock, 2011.
Antarctic	
Blue Whale	IWC, 2003.
Fin Whale	IWC, 2003.
Humpback Whale	IWC, 2003.
Antarctic Minke Whale	Hakamada, 2013a; Hakamada, 2013b; Branch, 2006.
Minke Whale	Kaschner et al., 2006.
Sei Whale	Kaschner et al., 2006.
Arnoux's Beaked Whale	Kaschner et al., 2006.
Gray's Beaked Whale	Kaschner et al., 2006.
Hourglass Dolphin	IWC, 2003.
Killer Whale	IWC, 2003.
Layard's Beaked Whale	IWC, 2003.
Long-finned Pilot Whale	IWC, 2003.
Southern Bottlenose Whale	IWC, 2003.
Sperm Whale	IWC, 2003.
Crabeater Seal	NZAI, 2001; CCAMLR, 2007; Pinkerton, Bradford-Grieve, n.d.; Ainley, 2009.
Leopard Seal	NZAI, 2001.
Ross Seal	Pinkerton, Bradford-Grieve, n.d.; NZAI, 2001; Bengston et al., 2011
Weddell Seal	NZAI, 2001; Pinkerton, Bradford-Grieve, n.d.; Ainley, 2009; CCAMLR, 2007.
Southern Elephant Seal	Pinkerton, Bradford-Grieve, n.d.; Ainley 2009.

Group Size

Many marine mammals are known to travel and feed in groups. NAEMO accounts for this behavior by incorporating species-specific group sizes into the animat distributions, and accounting for statistical uncertainty around the group size estimate. Group sizes were collected for each species via a search of the available peer reviewed literature and survey data. Standard deviations area also incorporated into NAEMO by randomly selecting a value from the poisson or lognormal distribution defined by the mean group size and standard deviation provided.

Dive Profiles

NAEMO accounts for depth distributions by changing each animat's depth during the simulation process according to the typical depth pattern observed for each species. Dive profile information was collected via literature search. This information is presented as a percentage of time the animal typically spends at each depth in the water column. During a simulation, each animat's depth is changed every four minutes to a value randomly selected by the probability density function described by its profile. At this time, NAEMO does not simulate horizontal animat movement.

Criteria and Thresholds for Assessing Impacts

Criteria and thresholds to assess impacts to marine mammals are synthesized from published study results (U.S. Navy 2017b) provides details on the derivation of the Navy's current impact criteria). These criteria and thresholds are used to assess potential effects to marine mammals and sea turtles in the analysis process.

B.9 NAVY ACOUSTIC EFFECTS MODEL

The following sections discuss the acoustic analysis, marine species distribution, simulation, and outputs from each of the NAEMO modules.

B.9.1 Icebreaking

Since the icebreakers associated with the Proposed Action have not been constructed yet, the best available information on their acoustic "signatures" (i.e., the distribution and intensities of different sound frequencies emitted) included Roth et al.'s (2013) study of CGC HEALY conducted in the central Arctic Ocean. Icebreaking can occur under full power, half power, quarter power, etc. Because sound signatures were not correlated to the icebreaker's power when icebreaking, the Roth et al. (2013) study provided sound signatures of the icebreaker in 8/10 ice coverage and 3/10 ice coverage, which were used in the NAEMO model to represent full power and quarter power ice breaking, respectively. The sound signature of the 5/10 icebreaking activities, which would correspond to half-power icebreaking, was not reported in (Roth et al. 2013); therefore, the full-power signature was used as a conservative proxy for the half-power signature.

The sound signature of each of the ice coverage levels was broken into 1-octave bins (Table B-3 and Table B-4). In the model, each bin was included as a separate source. When these independent sources go active concurrently, they simulate the sound signature of CGC Healy. The modeled source level summed across these bins was 196.2 dB re 1 μPa @ 1 m for the 8/10 signature and 189.3 dB re 1 μPa @ 1 m for the 3/10 ice signature. These source levels are a good approximation of the icebreaker's observed source level (provided in Figure 4b of (Roth et al. 2013). The full-power (8/10 ice coverage) signature was used for the half-power icebreaking, which provides a conservative estimate of the effects for half-power icebreaking. Each frequency and source level was modeled as an independent source, and applied simultaneously to all of the animats within NAEMO. Each second was summed across frequency to estimate sound pressure level (SPL; root mean square [SPL_{RMS}]). This value was incorporated into the behavioral risk function to estimate behavioral exposures. For permanent and temporary threshold shift determinations, sound exposure levels were summed over the duration of icebreaking (Table B-7).

Table B-3. Modeled Bins for 8/10 Ice Coverage (Full Power) for CGC HEALY

Frequency (Hz)	Source Level (dB re 1 μPa @ 1 m)
25	189
50	188
100	189
200	190
400	188
800	183
1600	177
3200	176
6400	172
12800	167

Table B-4. Modeled Bins for 3/10 Ice Coverage (Quarter Power) for CGC HEALY

Frequency (Hz)	Source Level (dB re 1 μPa @ 1 m)
25	187
50	182
100	179
200	177
400	175
800	170
1600	166
3200	171
6400	168
12800	164

NAEMO accounted for the typical speed of the icebreaker while icebreaking at 4 knots. NAEMO also incorporated the number of days and hours of icebreaking during the Antarctic and Arctic missions (Table B-5).

Table B-5. Total Number of Days and Hours Per Day that an Icebreaker Would Be Expected to Ice Break or Tow a Vessel (in Ice) in Arctic and Antarctic

Icebreaking	Antarctic		Arctic	
	Number of Days	Number hours/day	Number of days	Number hours/ day
8/10s ice cover	4	16	10	16
3/10s ice cover	22	16	11	16
Vessel Tow in Ice				
	1	4	X	X

B.9.2 Acoustic Analysis

In NAEMO, the Acoustic Builder module generates propagation data. First, it uses event definitions from NAEMO to extract source characteristics and environmental data for a given location. It then uses a standard resolution for a set of propagation analysis points in the event's location. For each analysis point, the Navy's standard propagation model (the Comprehensive Acoustic Simulation System/ Gaussian Ray Bundle [CASS/GRAB]) is run to generate a sound field for each source in the scenario. For non-impulsive sources the sound field data is saved in NAEMO and subsequently provided as input to Scenario Simulator.

B.9.3 Comprehensive Acoustic Simulation System/ Gaussian Ray Bundle

The CASS/GRAB model is used to determine the propagation characteristics for acoustic sources with frequencies greater than 150 Hz. Keenan and Gainey (2015) described CASS as "a linear acoustics, range-dependent, ray-based eigenray model that calculates arrival structure, sound pressure, reverberation, signal excess, and probability of detection." NAEMO analyses use CASS in the passive propagation mode, that is, one-way propagation, rather than the active mode, which uses two-way propagation. CASS uses acoustic rays to represent sound propagation in a medium. As acoustic rays travel through the ocean, their paths are affected by mechanisms such as absorption, reflection, and reverberation, including backscattering, and boundary interaction. The CASS model determines the acoustic ray paths between the source and a particular location in the water. The rays that pass through a particular point are called eigenrays.

GRAB's role in the propagation model is to group eigenrays into families based on their surface/bottom bounce and vertex history (Figure B-2). For example, a ray that bounces off the surface and then off the ocean floor would be in a different family than a ray that bounces off the floor first and then the surface. Rays with no boundary interaction would be in yet another family. Once the eigenrays have been grouped into families, the ray path properties are integrated (source angle, arrival angle, travel time, phase, and amplitude) to determine a representative ray for each family. These properties are weighted prior to integration so that rays closer to the desired target depth have more weight. Each representative eigenray, based on its intensity and phase, contributes to the complex pressure field, and hence, to the total energy received at a point. The total received energy at a point is calculated by summing the modeled eigenrays. Figure B-3 shows the representative eigenrays for the families shown in Figure B-4. The total received energy at the receiving point (50 m depth, 1.4 km range) is calculated by summing the representative eigenrays. CASS/GRAB accommodates surface and bottom boundary interactions, but does not account for side reflections that would be a factor in a highly reverberant environment, such as a depression or canyon, or in a man-made structure, such as a dredged harbor. Additionally, as with most other propagation models except finite-element-type models, CASS/GRAB does not accommodate diffraction or the propagation of sound around bends.

CASS/GRAB generates a table of depth range points with an associated received level per location and per source. For non-impulsive sources, these received levels are used as input into Scenario Simulator.

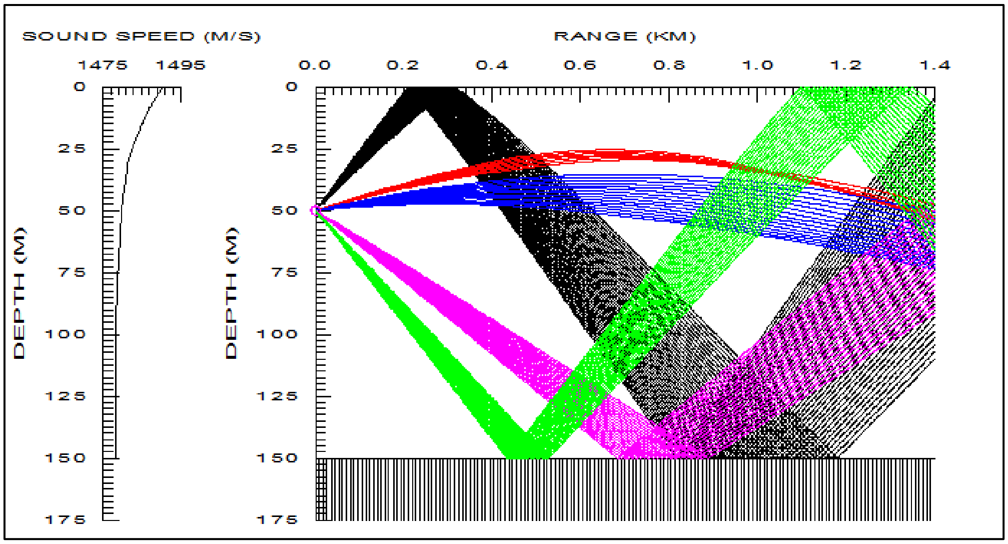

Figure B-3. Colors Represent Distinct Families of Eigenrays Identified by GRAB

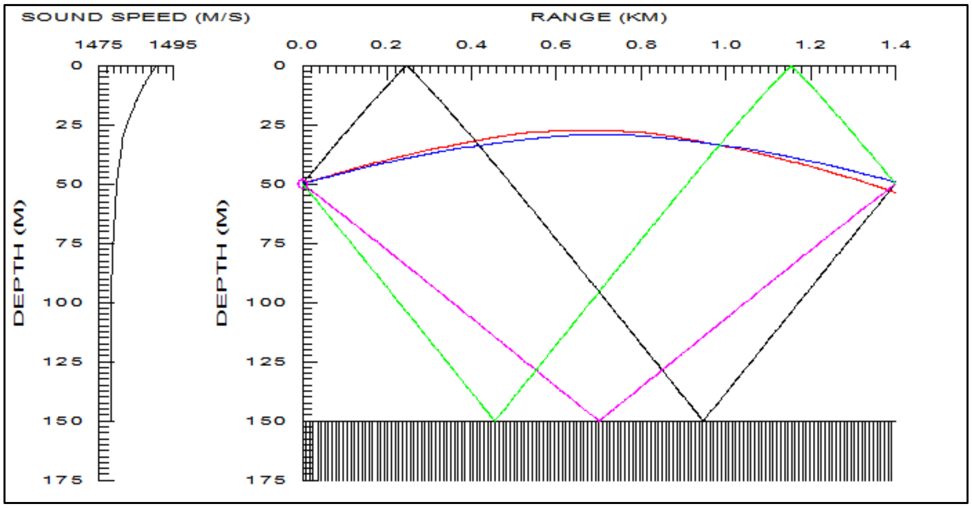

Figure B-4. Representative Eigenrays for the Ray Families in Figure B-3.

B.9.4 Non-Impulsive Model

The following features were included in Acoustic Builder for non-impulsive events:

- Events can be visually inspected and verified before modeling begins. For example, Acoustic Builder allows the user to view an event's geographic location, range complex, platforms, sources, bathymetry, modeling boxes, and local species distributions.
- Users can select analysis points to be run by CASS/GRAB. This can be done automatically by giving Acoustic Builder spacing between points, which it uses to create a grid of equally spaced analysis points. Or, users can manually select analysis points.
- Acoustic Builder provides a graphical user interface for CASS/GRAB and runs the propagation model at every analysis point selected.

- Acoustic propagation is run along 18 equally spaced radials (bearing angles) from an analysis point to 100 km, or until the received level has reached 100 dB.

B.9.5 Marine Species Distribution Builder

Marine mammals are distributed into simulation areas with the representative locations for the proposed action areas (Arctic and Antarctic), and multiple iterations are run for each species to account for statistical uncertainty in the density estimates. Each iteration varies according to the standard error associated with the density estimate (U.S. Navy 2014a). The density data are provided as a geographic grid (typically 10 km x 10 km) in which each cell is assigned a species density (animals/km^2). One density grid for each species was provided. In many cells, a standard deviation was provided with the density estimate. However, for areas where density predictions were made for non-surveyed areas, the density cells were so far away from any survey measurement that the estimated statistical uncertainty would not be meaningful. In these cases standard error was not provided. Group size and dive profiles were taken into account as discussed in Section B.8. Animats were used during modeling to function as a dosimeter, recording energy received from icebreaking during a scenario.

The distribution of animats in NAEMO starts with the extraction of species density estimates by area and month. In order to incorporate statistical uncertainty surrounding density estimates into NAEMO, 30 distributions were produced for each species for each season (cold or warm), each of which varied according to the standard deviations provided with the density estimates. The following steps are then taken to distribute the animats within the defined modeling space:

- In each cell, the density estimate for that iteration is determined by randomly selecting a single value from a distribution defined by the density estimate (the mean of the distribution) and its standard deviation. If the density estimate did not have a corresponding standard deviation, the density remained constant at the mean for every iteration.
- The density estimate (animals/km2) for that iteration is multiplied by the cells' area (km2) to obtain the total number of animats in that cell.
- The total number of animats in each cell is summed across the entire area to determine the total number of animats in the entire area.
- Animats are placed into groups according to mean and standard deviation of group size. Groups are created until total abundance is reached.
- Groups of animats are then distributed into cells according to the probability density function defined by the original density estimates provided.

These steps result in a series of data files containing the time, location, and depth of each animat placed within the modeling area. The standard deviation was only used to vary the total number of animats in the entire region. This is necessary because, as a consequence of extrapolating the regression models into areas without survey measurements, the statistical uncertainty in these cells was substantially higher than in areas with survey measurements. An unrealistically high number of animats was often selected for these cells, which warped the population's spatial distribution.

B.9.6 NAEMO Simulation Process

The NAEMO simulation process combines all of the previously defined data and estimates the acoustic effects on marine mammals. The first module, Scenario Simulator, combines scenario definitions from

Scenario Builder, data created in Acoustic Builder, and animat distributions created in Marine Species Distribution Builder to produce a record in NAEMO of the sound received by each animat. The second module, Post Processor, reads the record created by Scenario Simulator, applies the frequency-based weighting functions, and conducts a statistical analysis to estimate effects associated with each marine mammal group based on the specified criteria thresholds. Results from each analysis are stored in NAEMO. The third and final module, Report Generator, provides a mechanism to assemble all of the individual species exposure records created by Post Processor and computes annual effect estimates. Estimated annual effects can be grouped by activity, season, and geographic region before outputting the results to comma-separated text files that can be used for further examination of the data. The following sections provide additional information for each module.

B.9.7 Monte Carlo Simulation Approach

Estimation of effects in NAEMO is accomplished through Monte Carlo simulations. This approach was chosen to account for the variability inherent in many factors of testing and training such as platform location and movement, precise location of modeling area, and instantaneous distributions of marine mammals. Additionally, NAEMO incorporates individual animat movement vertically in the water column at a specified displacement frequency for sufficient sampling of the depth dimension. Individual animats are not moved horizontally within NAEMO. The location of an event is randomly selected within a specified modeling area. NAEMO uses unique iterations of the simulated animal populations in each simulation, which allows it to provide sufficient sampling in the horizontal dimensions for statistical confidence. Monte Carlo simulations also produce statistically independent samples, which allows for the calculation of metrics such as standard error and confidence intervals. Thirty Monte Carlo simulations are run per event, per species, and per season. In each simulation, these factors are randomly selected:

- modeling box (the area to which platforms are restricted)
- geographic location of animats
- depth of each animat (updated at four minute intervals during simulation)
- platform start location within the modeling box
- platform track (unless platform is stationary or its track is defined by waypoints)
- time that source first goes active (unless timing is specified in scenario definition)

B.9.8 Scenario Simulator

The purpose of Scenario Simulator is to determine the level of sound received by each animat. This module references the scenario definition in NAEMO to determine the starting location, direction, and depth of each platform. Scenario Simulator then steps through time and integrates sources to determine which are actively emitting sound during that time step.

The simulation begins with a time equal to zero and progresses incrementally in 1-second steps until the end of the scenario. For each source, the beam pattern area and direction of sound source emission is computed. The beam pattern area is calculated from the horizontal beam pattern and maximum propagation distance, which are stored in the source table in NAEMO. The next step in the process identifies all animats that fall within each defined beam pattern area.

Propagation data are computed at multiple points within each modeling box to account for platforms moving during the simulation. The exception to this is scenarios that involve only stationary platforms. At each time step, the position of each platform is compared to the locations of each propagation analysis point to determine the closest propagation file.

For each animat identified in the beam pattern, a lookup in the sound source propagation file is performed to determine the received sound level for that animat. The lookup is conducted based on the bearing and distance from the platform to the animat and the depth of the animat. The closest matching point within the propagation file is used.

Simulation output for each animat is stored in NAEMO. These outputs include simulation time, platform name, source name, source mode name, source mode frequency, source mode level, ping length (not applicable in icebreaking), platform location (latitude/longitude), platform depth, species name, animal identification number, animal location (latitude/longitude), animal depth, animal distance from source, and sound received levels.

B.9.9 Post Processor

Post Processor uses output from Scenario Simulator to compute the impact of events on each marine mammal group. Criteria and thresholds are applied to Monte Carlo simulations which are then combined to provide a mean estimate of effects for each event.

Post Processor uses two metrics to describe sound received by animats, Sound Pressure Level (SPL) and Sound Exposure Level (SEL). Post Processor computes maximum SPL and accumulated SEL over the entire duration of the event for each animat. The maximum SPL, which is used to determine behavioral effects, is simply the maximum received level reported in Scenario Simulator. Accumulated SEL is used to determine PTS and TTS, and represents the accumulation of energy from all time-steps and from multiple source exposures. See Table 4-3 in this PEIS for the PTS and TTS thresholds used. For SEL, the appropriate auditory weighting functions defined by the marine mammal criteria are applied to adjust the received levels. SEL is given by:

$$\mathrm{SEL}_{s,t} = \mathrm{SPL}_{\mathrm{weighted},t} + 10 \times \log(PL_s) \quad (2)$$

Where s is source s, t is time t, $\mathrm{SPL}_{\mathrm{weighted},t}$ is the received level adjusted by the species auditory weighting function at time t, and PL_s is the pulse length of source s. The SEL values are then power

$$\text{Cumulative SEL}_s = 10 \times \log\left(\sum_{t=1}^{n} 10^{\mathrm{SEL}_{s,t}/10}\right) \quad (3)$$

summed across time to give a cumulative SEL for each source where *n* is the number of time steps for the given source. After these calculations, the cumulative SEL is once more power summed across sources for each animat to determine the final cumulative SEL. A mean number of SPL and SEL simulated exposures are computed for each 1-dB bin. The mean value is based on the number of animats exposed at that dB level from each track iteration. The Behavioral Response Function (BRF) curve is applied to each 1-dB SPL bin to compute the number of behaviorally affected animats per bin (Figure B-5). The number of behaviorally affected animats per bin is summed to produce the total number of behavioral effects.

Mean 1-dB bin SEL exposures are then summed to determine the number of instances in which PTS and TTS thresholds were exceeded. PTS values represent the cumulative number of animats affected at or above the PTS threshold. TTS values represent the cumulative number of animats affected at or above the TTS threshold and below the PTS threshold. Each animat can only be reported under a single criterion (e.g., once an animat is reported for PTS, it would not additionally be reported under TTS or behavioral).

Because the exact distribution of individual animals and exact path of the ship during the icebreaking activities is not known, the modeling process randomly varied the distribution and track over the course of multiple simulations. By averaging the number of behavioral affects, TTS, and PTS across all simulations, results account for uncertainty in exact ship and animal location.

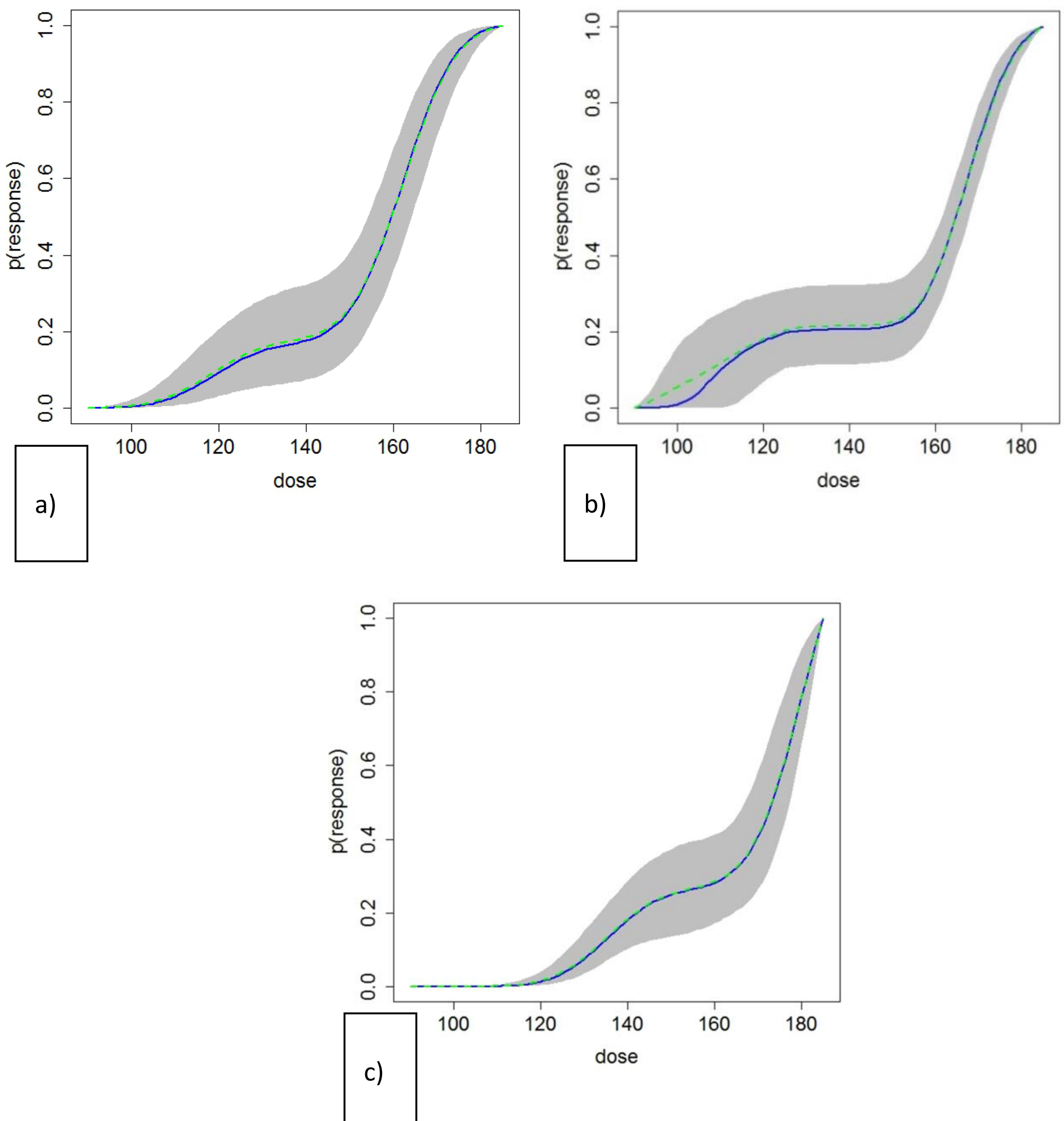

Figure B-5. Bayesian Biphasic Dose-response BRF for a) Odontocetes b) Pinnipeds and c) Mysticetes. The blue solid line represents the Bayesian Posterior median values, the green dashed line represents the biphasic fit, and the gray represents the variance. [X-Axis: Received Level (dB re 1 µPa), Y-Axis: Probability of Response]

B.9.10 NAEMO Modeling Results

All scenarios analyzed in NAEMO were evaluated as single events occurring within a given season and location. The annual estimated effects for a single scenario are determined by taking the average of all seasons and locations modeled for that scenario. To create the average effects, each scenario was multiplied by a factor based on the number of seasons, locations, and events per season that scenario would be conducted. Each factored scenario effect is then summed together to produce the average scenario effect. Total annual effects resulting from all scenarios modeled are then the summation of each scenario's averaged effect.

CASS/GRAB is the Navy's standard ray trace model for computing the propagation of sound in an underwater environment. As with any computational model there are inherent limitations on how and where the model should be used, particularly when it comes to modeling icebreaking.

The ship's specific position and heading is uncertain, at this time; however, in NAEMO a trackline was "assigned" for simulation purposes. For example, in the Antarctic, a representative route in the representative modeling location was used to simulate breaking into McMurdo Station. The maximum distance (100 km) or received level of 100 dB (see Section B.9.4) was used to analyze acoustic propagation and transmission loss. For non-impulsive sources, NAEMO calculates the sound pressure level (SPL) and sound exposure level (SEL) for each active emission during an event. This is done by taking the following factors into account over the propagation paths: bathymetric relief and bottom types, sound speed, and attenuation contributors such as absorption, bottom loss, and surface loss. The icebreaker was modeled in accordance with relevant vehicle dynamics and time duration, and by moving it across the representative location area. An example of how range to effects was considered is provided using the Antarctic as the representative location. Table B-6 provides the range to effects for icebreaking for marine mammals present in the Antarctic proposed action area relative to the TTS criteria, in SEL, for each hearing group. Range to effects to PTS was not calculated as modeling resulted in zero PTS. Marine mammals within the ranges presented in Table B-6 would be predicted to receive the associated effect. Ranges included the duration, in seconds, ranging from 10 seconds to 3600 seconds (the maximum) and assumed the lowest possible speed, 2 knots, that the icebreaker might ice break. Realistically, the icebreaker would likely travel at $\geq$ 3 knots while icebreaking, but in calculating range to effects, the scheme that provided the most extreme of all of the possibilities was evaluated (i.e. slowest speed and longest duration). Of note, the noise produced by the icebreaker propagated in a radial pattern around the source (the icebreaker, see Figure B-6).

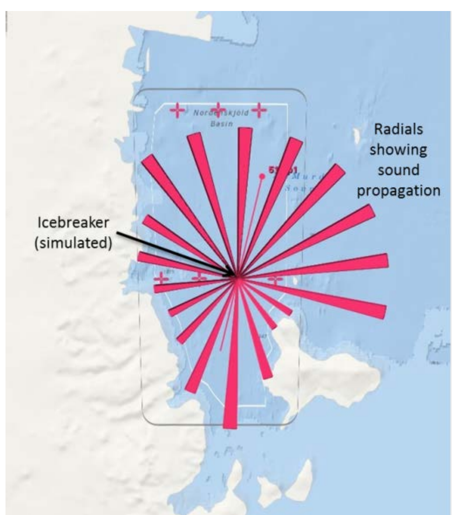

Figure B-6. Representation of Icebreaking Sound as It Propagates When Breaking in to McMurdo Sound, Antarctica

Therefore, the ranges in Table B-6 provide realistic maximum distance over which TTS from icebreaking could be possible. This information predicts potential acoustic impacts, but also verifies the accuracy of model results (in this case, these were also measured against spherical spreading loss of 20 log r [20 times the log (base 10) of the radius (or range)]). Based on the range to effects TTS results, the number of takes anticipated for all marine mammal hearing groups in the Antarctic by TTS is rounded up to zero (see Table B-7 for all results). The estimate for TTS takes were calculated by taking the area for TTS (the ratio of the circle circumference [acoustically the sound propagation radiated around the ship during icebreaking] and the maximum range for TTS) multiplied by the species density (/square kilometer).

Table B-6. Range to Temporary Threshold Shift in the Antarctic Proposed Action Area.

Hearing Group	Ice Cover	TTS Criteria (SEL)	Range to Effects (m) Maximum Range for TTS	Number of Takes [TTS]= area for TTS (km^2) x density (/sqkm)
Low Frequency Cetacean	3/10	179	100	0
	8/10		625	0
Mid Frequency Cetacean	3/10	178	20	0
	8/10		30	0
High Frequency Cetacean	3/10	153	480	0
	8/10		725	0
Phocid (in water)	3/10	181	35	0
	8/10		95	0

As noted earlier, model outputs include the number of behavioral affects, TTS, and PTS per species and icebreaking scenario (8/10 ice cover and 3/10 ice cover). Results in Table B-7 are the expected average for a single, annual patrol in the Arctic or Antarctic.

Table B-7. Marine Mammal Acoustic Exposure from Icebreaking in the Arctic and Antarctic Proposed Action Areas

Common Name	Behavioral		TTS		PTS	
	8/10s ice cover	3/10s ice cover	8/10s ice cover	3/10s ice cover	8/10s ice cover	3/10s ice cover
Mysticetes						
Arctic						
Bowhead whale	1	1	0	0	0	0
Antarctic						
Antarctic minke whale	49	224	0	0	0	0
Blue whale	3	12	0	0	0	0
Humpback whale	13	59	0	0	0	0
Minke whale	50	237	0	0	0	0
Odontocetes						
Antarctic						
Arnoux's beaked whale	50	275	0	0	0	0
Gray's beaked whale	5	29	0	0	0	0
Killer whale	45	169	0	0	0	0
Southern bottlenose whale	44	243	0	0	0	0
Pinnipeds and Carnivores						
Arctic						
Bearded seal	42	41	0	0	0	0
Polar bear	13	14	0	0	0	0

Common Name	Behavioral		TTS		PTS	
	8/10s ice cover	3/10s ice cover	8/10s ice cover	3/10s ice cover	8/10s ice cover	3/10s ice cover
Ringed seal	764	810	0	0	0	0
Antarctic						
Crabeater seal	404	1962				
Leopard seal	23	117	0	0	0	0
Ross seal	15	75	0	0	0	0
Weddell seal	18	90	0	0	0	0

APPENDIX C RESPONSES TO PUBLIC COMMENTS

This Draft PEIS assessed how operations and training activities associated with the polar icebreaker program acquisition strategy could potentially impact human and natural resources. Following publication of the Notice of Availability (NOA) to prepare a Programmatic EIS in the Federal Register, the Coast Guard has prepared this Draft PEIS in accordance with the NEPA, as implemented by the CEQ Regulations (40 CFR §§ 1500 et seq.); Department of Homeland Security Directive Number 023-01; and Coast Guard Commandant Instruction M16475.1D.

Following a 45-day public comment period on the Draft PEIS, the Coast Guard will review and respond to comments in writing and, if appropriate, incorporate changes in the Final PEIS. The Final PEIS will be circulated for a 30-day wait period. Following the 30-day wait period, the Coast Guard will prepare a Record of Decision that will formally document the selected alternative for the project and mitigation to be implemented by the Coast Guard, and address substantive new comments received on the Final PEIS.

Placeholder: *This section is incomplete because the Coast Guard intends to conduct a 45-day public comment period on the Draft PEIS and will update this section before the Final PEIS is completed.*

APPENDIX D CHANGES BETWEEN DRAFT PEIS AND FINAL PEIS

Placeholder: *This section is incomplete because the Coast Guard intends to conduct a 45-day public comment period on the Draft PEIS and will update this section before the Final PEIS is completed.*