3.4 Marine Mammals

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3.4 Marine Mammals

3.4.1 Affected Environment

This section (Section 3.4, Marine Mammals) of this Supplemental provides general background information on marine mammals present in the Northwest Training and Testing (NWTT) Study Area and provides the analysis of potential impacts to those marine mammals that may result from Navy training and testing activities using sonar and other transducers and in-water explosives. Section 3.4.1 (Affected Environment) provides an introduction to the species that occur in the NWTT Study Area. The complete analysis and summary of potential impacts of the Proposed Action on marine mammals are found in Sections 3.4.2 (Environmental Consequences), 3.4.3 (Summary of Impacts [Combined Impacts of All Stressors] on Marine Mammals), and 3.4.3.4 (Summary of Monitoring and Observations During Navy Activities Since 2015). For additional information, also see the 2015 NWTT Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), Section 3.4 (Marine Mammals) (U.S. Department of the Navy, 2015a).

3.4.1.1 General Background

Marine mammals are a diverse group of approximately 130 species. Most live predominantly in the marine habitat, although some species, such as seals, spend time in terrestrial habitats, and other species such as manatees and certain dolphins spend time in freshwater habitats (Jefferson et al., 2015; Rice, 1998). The exact number of formally recognized marine mammal species changes periodically with new scientific understanding or findings (Rice, 1998). For a list of current species classifications, see the formal list Marine Mammal Species and Subspecies maintained online by the Society for Marine Mammalogy (Committee on Taxonomy, 2017, 2018). In this document, the Navy follows the naming conventions presented by the National Marine Fisheries Service (NMFS) in the applicable annual Stock Assessment Reports (SAR) for the Pacific and Alaska covering the marine mammals present in the Study Area (Carretta et al., 2019c; Carretta et al., 2018a, 2018b; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a).

All marine mammals in the United States (U.S.) are protected under the Marine Mammal Protection Act (MMPA), and some species receive additional protection under the Endangered Species Act (ESA). The MMPA defines a marine mammal "stock" as "a group of marine mammals of the same species or smaller taxon in a common spatial arrangement that interbreed when mature" (16 United States Code [U.S.C.] section 1362; for further details, see Oleson et al. (2013)). As provided by NMFS guidance, "for purposes of management under the MMPA a stock is recognized as being a management unit that identifies a demographically independent biological population" (Carretta et al., 2017c; National Marine Fisheries Service, 2016d). However, in practice, recognized management stocks may fall short of this ideal because of a lack of information or for other reasons and, in some cases, may even include multiple Distinct Population Segments (DPS) in a management unit, such as with the California/Oregon/Washington stock of humpback whale (Bettridge et al., 2015; Titova et al., 2017).

The ESA provides for listing species, subspecies, or DPSs of species, all of which are referred to as "species" under the ESA. The Interagency Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the ESA defines a DPS as, "any subspecies of fish or wildlife or plants, and any DPS of any species of vertebrate fish or wildlife which interbreeds when mature" (61 Federal Register [FR] 4722; February 7, 1996; 81 FR 62660, September 8, 2016). In short, a DPS is a portion of a species' or subspecies' population that is both discrete from the remainder of the population and significant in relation to the entire species, with the DPS then defined geographically instead of biologically.

If a population meets the criteria to be identified as a DPS, it is eligible for listing under the ESA as a separate species (National Marine Fisheries Service, 2016d). MMPA stocks do not necessarily coincide with DPSs under the ESA (FR 81[174]: 62660-62320, September 8, 2016). For example, in the Study Area there are humpback whales seasonally present from two stocks and three distinct population segments (Bettridge et al., 2015; Carretta et al., 2018a; Carretta et al., 2017c; Muto et al., 2017; National Marine Fisheries Service, 2016f, 2016l; Titova et al., 2017). Central North Pacific stock humpback whales are presented in the Alaska SAR (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a) and that stock includes both the Hawaii and the Mexico DPSs; however, the Mexico DPS is also included in the California, Oregon, Washington stock along with the Central America DPS (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017c). Consistent with NMFS determination for the U.S. Exclusive Economic Zones (EEZ) in the Pacific, the fourth humpback whale DPS present in the Pacific (the Western North Pacific DPS) is not recognized as being present in Alaska or U.S. Pacific coast waters, and so is assumed not to be present in the Study Area during Navy training and testing activities. NMFS is in the process of reviewing humpback whale stock structure in light of the 14 DPSs and stock inconsistencies, but revisions to the species stock structure for the Pacific will not occur until the NMFS review is complete (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017d; Muto et al., 2018a; Muto et al., 2018b; Muto et al., 2019a); an estimated date for completion of the review has not been provided. Further details on the stocks and DPSs found in the Study Area are provided in the applicable species-specific subsections that follow.

As presented in the 2015 NWTT Final EIS/OEIS in Section 3.4.2.5 (Marine Mammal Density Estimates) and the applicable humpback whale and gray whale discussions, the Navy previously analyzed training and testing activities with regard to locations where cetaceans are known to engage in activities at certain times of the year that are important to individual animals as well as populations of marine mammals (see discussion in (Ferguson et al., 2015b; Van Parijs et al., 2015). As explained in Van Parijs et al. (2015), each such location was identified as a Biologically Important Area. For purposes of the analyses in this Supplemental, that information has been presented in Appendix K (Geographic Mitigation Assessment) and includes any emergent scientific information available since the 2015 analyses. New information in this regard has also been incorporated into the marine mammal distributions and density data presented in the Navy's NWTT Marine Species Density Database Technical Report (U.S. Department of the Navy, 2020).

There are 30 marine mammal species known to exist in the Study Area, including 7 mysticetes (baleen whales), 16 odontocetes (dolphins and toothed whales), 6 pinnipeds (seals and sea lions), and the Northern sea otter. Among these species there are multiple stocks and DPSs managed by NMFS and the Northern sea otter managed by the U.S. Fish and Wildlife Service (USFWS) in the United States EEZ. The marine mammal species and their occurrence in the Study Area are provided in Table 3.4-1. The information presented in this Supplemental incorporates data from the U.S. Pacific and the Alaska Marine Mammal SARs (Carretta et al., 2019c; Carretta et al., 2018a, 2018b; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a; U.S. Fish and Wildlife Service, 2018), which cover those species present in the Study Area, and incorporates the best available science, including monitoring data from Navy marine mammal research efforts.

Table 3.4-1: Marine Mammals and Their Occurrence Within the NWTT Study Area

Common Name[1]	*Scientific Name*	*ESA Status*	*Stock[2]*	*Occurrence in Study Area*			
				Offshore Area	*Inland Waters*	*Western Behm Canal*	*Regional Notes*
Order Cetacea							
Suborder Mysticeti (baleen whales)							
Family Balaenidae (right whales)							
North Pacific right whale	*Eubalaena japonica*	Endangered	Eastern North Pacific	Rare	—	—	Extremely unlikely presence in the Offshore Area. Extralimital in Inland Waters and Western Behm Canal.
Family Balaenopteridae (rorquals)							
Blue whale	*Balaenoptera musculus*	Endangered	Eastern North Pacific	Seasonal	—	—	Seasonal occurrence in the Offshore Area. Highest likelihood in summer and fall and detected acoustically August through February. Extralimital in the Inland Waters and Western Behm Canal.
Fin whale	*Balaenoptera physalus*	Endangered	Northeast Pacific	—	—	Rare	This stock is extralimital in the Offshore Area and Inland Waters. Rare occurrence in Western Behm Canal.
		Endangered	California, Oregon, and Washington	Seasonal	Rare	—	Seasonal occurrence in the Offshore Area; high numbers in summer and fall and detected acoustically July through April. Rare in Inland Waters. This stock is extralimital in Western Behm Canal.
Sei whale	*Balaenoptera borealis*	Endangered	Eastern North Pacific	Regular	—	—	Likely occurrence in the Offshore Area. Extralimital in Inland Waters and Western Behm Canal.
Minke whale	*Balaenoptera acutorostrata*	NA	Alaska	—	—	Rare	This stock extralimital in the Offshore Area and Inland Waters. Rare occurrence in Western Behm Canal.

Table 3.4-1: Marine Mammals and Their Occurrence Within the NWTT Study Area (continued)

Common Name[1]	*Scientific Name*	*ESA Status*	*Stock*[2]	*Occurrence in Study Area*			
				Offshore Area	*Inland Waters*	*Western Behm Canal*	*Regional Notes*
Minke whale	*Balaenoptera acutorostrata*	NA	California, Oregon, and Washington	Regular	Seasonal	—	Likely occurrence in the Offshore Area. Seasonal occurrence in Inland Waters; more likely spring to fall. Rare in the Puget Sound. This stock is extralimital in Western Behm Canal.
Humpback whale[3]	*Megaptera novaeangliae*	Hawaii DPS (NA) Mexico DPS (T) Central America DPS (E)[3]	Central North Pacific	Regular	Regular	Regular	Likely with highest numbers in summer and fall but subset of populations may be present year round.
			California, Oregon, and Washington	Regular	Regular	Regular	Likely with highest numbers in summer and fall but subset of populations may be present year round.
Family Eschrichtiidae (gray whale)							
Gray whale	*Eschrichtius robustus*	NA	Eastern North Pacific	Seasonal	Seasonal	—	Likely occurrence in the Offshore Area and Inland Waters; not expected in Western Behm Canal.
		Endangered	Western North Pacific	Rare	Rare	—	Rare possible occurrence in the Offshore Area or Inland Waters; not expected in Western Behm Canal.
Suborder Odontoceti (toothed whales)							
Family Delphinidae (dolphins)							
Common bottlenose dolphin	*Tursiops truncatus*	NA	California, Oregon, and Washington	Regular	—	—	Regular occurrence in the Offshore Area. Extralimital in the Inland waters and Western Behm Canal.
Killer whale	*Orcinus orca*	NA	Eastern North Pacific Alaskan Resident	—	—	Regular	This stock is extralimital outside of Alaska waters. Likely occurrence in Western Behm Canal.

Table 3.4-1: Marine Mammals and Their Occurrence Within the NWTT Study Area (continued)

Common Name[1]	Scientific Name	ESA Status	Stock[2]	Occurrence in Study Area			
				Offshore Area	Inland Waters	Western Behm Canal	Regional Notes
Killer whale	*Orcinus orca*	NA	Eastern North Pacific Northern Resident	Seasonal	Seasonal	—	Seasonal rare presence in the Offshore Area and the Strait of Juan de Fuca portion of the Inland Waters. Not expected in Western Behm Canal.
		NA	West Coast Transient	Regular	Regular	Regular	Regular occurrence in all portions of the Study Area.
		NA	Eastern North Pacific Offshore	Regular	—	Regular	Likely occurrence in the Offshore Area and Western Behm Canal.
		Endangered	Eastern North Pacific Southern Resident	Regular	Regular	—	Regular occurrence given a variable presence during every month of the year in either the Offshore Area or the Inland Waters. Extralimital in Western Behm Canal.
Northern right whale dolphin	*Lissodelphis borealis*	NA	California, Oregon, and Washington	Regular	—	—	Likely occurrence in the Offshore Area. Extralimital in the Inland Waters and Western Behm Canal.
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	NA	North Pacific	—	—	Regular	This stock is extralimital to the Offshore Area and Inland Waters. Likely occurrence in Western Behm Canal; higher numbers in the spring.
		NA	California, Oregon, and Washington	Regular	Regular	—	Likely occurrence in the Offshore Area. Occurrence in the Inland Waters varies. Seasonal in Strait of Juan de Fuca and San Juan Islands, but extralimital in the Puget Sound. Likely present in Western Behm Canal.
Risso's dolphin	*Grampus griseus*	NA	California, Oregon, and Washington	Regular	Rare	—	Likely occurrence in the Offshore Area; rare occurrence in the Inland Waters; extralimital in Western Behm Canal.

Table 3.4-1: Marine Mammals and Their Occurrence Within the NWTT Study Area (continued)

Common Name[1]	*Scientific Name*	*ESA Status*	*Stock*[2]	*Occurrence in Study Area*			
				Offshore Area	*Inland Waters*	*Western Behm Canal*	*Regional Notes*
Short-beaked common dolphin	*Delphinus delphis*	NA	California, Oregon, and Washington	Regular	Rare	—	Likely occurrence in the Offshore area; more likely off of California coast. Rare occurrence in the Inland Waters; extralimital in Western Behm Canal.
Short-finned pilot whale	*Globicephala macrorhynchus*	NA	California, Oregon, and Washington	Regular	Rare	—	Likely occurrence but few in numbers in the Offshore Area. Rare possible presence in the Inland Waters; extralimital in Western Behm Canal.
Striped dolphin	*Stenella coeruleoalba*	NA	California, Oregon, and Washington	Regular	—	—	Likely occurrence in the deep ocean portion of the Offshore Area. Extralimital in the Inland Waters and Western Behm Canal.
Family Kogiidae (*Kogia* spp.)							
Dwarf sperm whale	*Kogia*	NA	California, Oregon, and Washington	Rare	—	—	There is a possibility the species is present in the Offshore Area extralimital in the Inland Waters and Western Behm Canal.
Pygmy sperm whale	*Kogia breviceps*	NA	California, Oregon, and Washington	Regular	—	—	Likely occurrence in the Offshore Area. Extralimital in the Inland Waters and Western Behm Canal.
Family Phocoenidae (porpoises)							
Dall's porpoise	*Phocoenoides dalli*	NA	Alaska	—	—	Regular	Likely year-round occurrence in Western Behm Canal.
		NA	California, Oregon, and Washington	Regular	Regular	—	Likely occurrence in the Offshore Area; fewer sightings in recent years in the Inland Waters.

Table 3.4-1: Marine Mammals and Their Occurrence Within the NWTT Study Area (continued)

Common Name[1]	*Scientific Name*	*ESA Status*	*Stock*[2]	*Occurrence in Study Area*			
				Offshore Area	*Inland Waters*	*Western Behm Canal*	*Regional Notes*
Harbor porpoise	*Phocoena phocena*	NA	Southeast Alaska[5]	—	—	Regular	Likely year-round occurrence in Western Behm Canal.
		NA	Northern Oregon/ Washington Coast	Regular	—	—	Likely occurrence in the Offshore Area of Northern Oregon and Washington.
		NA	Northern California/ Southern Oregon	Regular	—	—	Likely occurrence in the Offshore Area of Northern California and Southern Oregon.
		NA	Washington Inland Waters	—	Regular	—	Likely occurrence in the Inland Waters.
Family Physeteridae (sperm whale)							
Sperm whale	*Physeter macrocephalus*	Endangered	North Pacific	—	—	—	Not expected in Western Behm Canal due to pelagic nature, and no sightings in Southeast Alaska interior waters.
		Endangered	California, Oregon, and Washington	Regular	—	—	Likely occurrence in the Offshore Area. More likely in waters > 1,000 m depth, most often > 2,000 m.
Family Ziphiidae (beaked whales)							
Baird's beaked whale	*Berardius bairdii*	NA	Alaska	—	—	—	Alaska stock not in NWTT Offshore waters. Not expected in Western Behm Canal due to preferred deep water habitat.
		NA	California, Oregon, and Washington	Regular	—	—	Likely occurrence in the Offshore Area. Extralimital in Inland waters and Western Behm Canal.

Table 3.4-1: Marine Mammals and Their Occurrence Within the NWTT Study Area (continued)

Common Name[1]	*Scientific Name*	*ESA Status*	*Stock*[2]	*Occurrence in Study Area*			
				Offshore Area	*Inland Waters*	*Western Behm Canal*	*Regional Notes*
Cuvier's beaked whale	*Ziphius cavirostris*	NA	Alaska	—	—	—	Alaska stock not in NWTT Offshore Area or Inland Waters; extralimital in Western Behm Canal.
		NA	California, Oregon, and Washington	Regular	—	—	Likely occurrence in Offshore Area. Extralimital in Inland Waters and Western Behm Canal.
Mesoplodont beaked whales[4]	*Mesoplodon spp.*	NA	California, Oregon, and Washington	Regular	—	—	Likely occurrence in Offshore Area. Extralimital in Inland Waters and Western Behm Canal.
Suborder Pinnipedia							
Family Otariidae (sea lions and fur seals)							
California sea lion	*Zalophus californianus*	NA	U.S. Stock	Seasonal	Regular	—	Likely occurrence Offshore Area and in Inland Waters. This stock is not expected to be present in Western Behm Canal.
Steller sea lion	*Eumetopias jubatus*	NA	Eastern U.S.	Regular	Seasonal	Regular	Likely present in the Offshore Area and a seasonal presence in the Inland Waters. Likely present in Western Behm Canal.
		Endangered	Western U.S.	Rare	Rare	Rare	Rare presence in the Offshore Area. Not expected in the Inland Waters. In Western Behm Canal, possible presence of a few juveniles on occasion.
Guadalupe fur seal	*Arctocephalus townsendi*	Threatened	Mexico to California	Seasonal	—	—	Likely occurrence in the Offshore Area; not expected in Inland Waters or Western Behm Canal.

Table 3.4-1: Marine Mammals and Their Occurrence Within the NWTT Study Area (continued)

Common Name[1]	*Scientific Name*	*ESA Status*	*Stock*[2]	*Occurrence in Study Area*			
				Offshore Area	*Inland Waters*	*Western Behm Canal*	*Regional Notes*
Northern fur seal	*Callorhinus ursinus*	NA	Eastern Pacific	Regular	—	Seasonal	Likely occurrence in the Offshore Area and not expected to occur in Inland Waters. This stock is seasonal in Western Behm Canal.
		NA	California	Regular	—	—	Likely occurrence in the Offshore Area and not expected to occur in Inland Waters. This stock is extralimital in Western Behm Canal.
Family Phocidae (true seals)							
Harbor seal	*Phoca vitulina*	NA	Southeast Alaska (Clarence Strait)	—	—	Regular	Likely occurrence in Western Behm Canal.
		NA	Oregon/ Washington Coast	Regular	Seasonal	—	Likely occurrence in the nearshore waters off Oregon and Washington Pacific Coast and some seasonal presence possible in the Inland Waters.
		NA	California	Regular	—	—	Likely in the nearshore waters off California's Pacific Coast.
		NA	Washington Northern Inland Waters	Seasonal	Regular	—	Seasonal occurrence in the Offshore Area's coastal waters and regular presence in the northern portion of the Inland Waters.
		NA	Hood Canal	Seasonal	Regular	—	Seasonal occurrence in the Offshore Area and regular presence in the Hood Canal portion of the Inland Waters.
		NA	Southern Puget Sound	Seasonal	Regular	—	Seasonal occurrence in the Offshore Area and regular presence in the Inland Waters of Southern Puget Sound.

Table 3.4-1: Marine Mammals and Their Occurrence Within the NWTT Study Area (continued)

Common Name[1]	*Scientific Name*	*ESA Status*	*Stock[2]*	*Occurrence in Study Area*			
				Offshore Area	*Inland Waters*	*Western Behm Canal*	*Regional Notes*
Northern elephant seal	*Mirounga angustirostris*	NA	California	Regular	Regular	Seasonal	Regular occurrence in the Offshore Area with higher at-sea seasonal presence. Seasonal presence of a few individuals in some areas of the Strait of Juan de Fuca; Infrequent and generally lone individuals in Puget Sound.
Order Carnivora							
Family Mustelidae							
Northern sea otter	*Enhydra lutris kenyoni*	NA	Southeast Alaska	—	—	—	This stock not expected in Western Behm Canal.
			Washington	Regular	—	—	Likely in the Offshore Area in northern Washington, but in nearshore shallow water areas.

Table 3.4-1: Marine Mammals and Their Occurrence Within the NWTT Study Area (continued)

Common Name[1]	***Scientific Name***	***ESA Status***	***Stock[2]***	***Occurrence in Study Area***			
				Offshore Area	***Inland Waters***	***Western Behm Canal***	***Regional Notes***

[1] Taxonomy follows the naming conventions of the Society for Marine Mammalogy Committee on Taxonomy (2017); (Committee on Taxonomy, 2018) and the NMFS stock assessment reports (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a; U.S. Fish and Wildlife Service, 2018)

[2] Stock names and designations for the U.S. Exclusive Economic Zones are from the Pacific SAR (Carretta et al., 2019c; Carretta et al., 2018a, 2018b; Carretta et al., 2017c; U.S. Fish and Wildlife Service, 2018), Alaska SAR (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a) and USFWS (U.S. Fish and Wildlife Service, 2018).

[3] Humpback whales in the Central North Pacific stock and the California, Oregon, and Washington stock are from three Distinct Population Segments based on animals identified in breeding areas in Hawaii, Mexico, and Central America (Carretta et al., 2019c; Carretta et al., 2018a, 2018b; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a; National Marine Fisheries Service, 2016a, 2016e, 2016g; Titova et al., 2017; Wade et al., 2016). Both stocks and all three DPSs co-occur in the NWTT Study Area (National Marine Fisheries Service, 2016e, 2016l).

[4] Due to the difficulty in distinguishing different Mesoplodon species from one another at sea during visual surveys off the U.S. Pacific Coast, the United States management unit for waters off California, Oregon, and Washington pursuant to MMPA has been defined by NMFS to include all Mesoplodon species that occur in an area. This is the case for the six Mesoplodont beaked whale species in the California, Oregon, and Washington stock (*M. densirostris*, *M. carlhubbsi*, *M. ginkgodens*, *M. perrini*, *M. peruvianus*, *M. stejnegeri*).

[5] At this time, no data are available to define stock structure for harbor porpoise on a finer scale in Alaska. However, based on comparisons with other regions, it is likely that several regional and sub-regional populations exist.

Notes: DPS = Distinct Population Segment; ESA = Endangered Species Act; NA = status is not applicable for those species that are not listed under ESA; T = Threatened; E = Endangered; U.S. = United States; Regular = a species that occurs as a regular or usual part of the fauna of the area, regardless of how abundant or common it is; Seasonal = species is only seasonally present in the NWTT Study Area; Rare = a species that occurs in the area only sporadically numbering only a few individuals; Extralimital = a species not expected to be in the designated area. Additional details regarding presence in the NWTT Study Area are provided in the species-specific subsections.

3.4.1.2 Species Unlikely to Be Present in Northwest Training and Testing Study Area

3.4.1.2.1 Bryde's Whale (*Balaenoptera edeni*)

Bryde's whales occur primarily in offshore oceanic waters of the north Pacific (Barlow et al., 2006; Bradford et al., 2017). Data suggest that winter and summer grounds partially overlap in the central north Pacific (Murase et al., 2015; Ohizumi, 2002; Ohizumi et al., 2002). Bryde's whales are distributed in the central north Pacific in summer; the southernmost summer distribution of Bryde's whales inhabiting the central north Pacific is about 20° north (N) (Kishiro, 1996). Some whales remain in higher latitudes (around 25° N) in both winter and summer, but are not likely to move poleward of 40° N (Jefferson et al., 2015; Kishiro, 1996). Bryde's whales in some areas of the world are sometimes seen very close to shore and even inside enclosed bays (Baker & Madon, 2007; Best, 1996). There is some evidence that Bryde's whales migrate, although limited shifts in distribution toward and away from the equator, in winter and summer, have been observed (Best, 1996; Cummings, 1985). They appear to have a preference for water temperatures between approximately 59° and 68° Fahrenheit (F) [15° and 20° Celsius (C)] (Yoshida & Kato, 1999), much warmer than those of the Study Area. Based on sighting data collected by Southwest Fisheries Science Center during systematic ship surveys in the northeast Pacific between 1986 and 2014, there were no sightings of Bryde's whales north of approximately 41°N (Barlow, 2016; Hamilton et al., 2009). There have not been Bryde's whale calls detected in any of the various acoustic monitoring efforts off the coast of Washington (Debich et al., 2014; Emmons et al., 2017; Kerosky et al., 2013; Širović et al., 2012a; Trickey et al., 2015). Unprecedented strandings of Bryde's whale occurred in Puget Sound with one in January and one in December 2010 (Cascadia Research Collective, 2011b). Both animals were immature and in poor nutritional condition, suggesting that they were beyond the species' normal range. The occurrence of Bryde's whale within the Study Area is considered extralimital as all regions within the Study Area are outside the normal range of this species' distribution.

3.4.1.2.2 False Killer Whale (*Pseudorca crassidens*)

False killer whales are found in tropical and temperate waters, and there have been no sightings of false killer whales north of about 30°N during systematic ship surveys conducted by NMFS in the northeast Pacific between 1986 and 2014 (Barlow, 2016; Hamilton et al., 2009). A mixed-species group of approximately 70 false killer whales and 200 common bottlenose dolphins was observed 500 kilometers (km) north of the Strait of Juan de Fuca (at 50°N), 180 km off the coast of British Columbia, in July 2017 and is the most northerly record for this false killer whales in the eastern North Pacific (Halpin et al., 2018). The researchers who made this observation suggested the presence of these species should be considered vagrant, accidental, or otherwise associated with the prolonged period of ocean warming along the Pacific Coast (Halpin et al., 2018). Norman et al. (2004) observed that most strandings for false killer whales in Washington and Oregon occurred during or within a year of an El Niño event. In the 1990s, a pod of nine false killer whales was recorded in Puget Sound south of the Tacoma Narrows for several months and then left (McLean & Persselin, 2003; Stacey & Baird, 1991), and there are reports of an individual false killer whale sighted in the 1990s in the waters of Juneau, British Columbia, and Tacoma (McLean & Persselin, 2003; U.S. Department of the Navy, 2017h). For the MMPA stock assessment reports, there are five management stocks of false killer whale within the U.S. EEZ around the Pacific islands of Hawaii, Palmyra, and American Samoa (Carretta et al., 2019c; Carretta et al., 2017c); there are no management stocks recognized for the U.S. West Coast or Alaska waters. The occurrence of false killer whale within the Study Area is considered extralimital as all regions within the Study Area are outside the normal range of this species' distribution.

3.4.1.2.3 Long-Beaked Common Dolphin (*Delphinus capensis*)

Common dolphins are represented by two species for management purposes in NMFS Pacific SAR (Carretta et al., 2019c; Carretta et al., 2017c), the long-beaked common dolphin (*Delphinus capensis*) and the short-beaked common dolphin (*Delphinus delphis*). There is scientific disagreement regarding the common dolphin taxonomy (Committee on Taxonomy, 2016), but the Navy is following NMFS naming conventions as presented in the Pacific SAR (Carretta et al., 2019c; Carretta et al., 2017c).

Waters off the central and Southern California coast are considered the northern range limit of long-beaked common dolphin distribution (Carretta et al., 2019c; Carretta et al., 2017c) and seasonal and inter-annual changes in abundance off California are assumed to reflect shifts in the movements of animals between U.S. and Mexican waters (Gerrodette & Eguchi, 2011). The population extends south into Mexico, and they are commonly found within 50 nautical miles (NM) of the coast (Carretta et al., 2019c; Carretta et al., 2017c; Gerrodette & Eguchi, 2011). There have been no sightings of long-beaked common dolphins north of about 38°N during systematic ship surveys conducted by the National Oceanic and Atmospheric Administration (NOAA) Southwest Fisheries Science Center in the northeast Pacific between 1986 and 2014 (Barlow, 2016; Hamilton et al., 2009). Based on habitat models derived from line-transect survey data collected between 1991 and 2009 off the U.S. West Coast, long-beaked common dolphins are distributed in nearshore waters south of about 37°N (Becker et al., 2020; Becker et al., 2016). Long-beaked common dolphins have been found stranded dead in the Pacific Northwest occasionally over the years (1953, 1993, 2002, 2003, and 2012). Two individual long-beaked common dolphins were observed during the summer of 2011 in the Puget Sound and again over 18 months in 2012–2013, but their presence was considered highly unusual (Cascadia Research, 2012a; Ford, 2005; Shuster et al., 2017). Between June 2016 and September 2017, 4–12 dolphins were regularly sighted in central and south Puget Sound in the summer, with aggregations of approximately 30 animals occurring on occasion (Shuster et al., 2017). Despite these recent sightings, the occurrence of long-beaked common dolphin within the Study Area is considered extralimital given that all regions within the Study Area are outside the normal range of this species' distribution according to the most recent NMFS stock assessment report concerning the species (Carretta et al., 2019c; Carretta et al., 2017d).

3.4.1.3 Group Size

Many species of marine mammals, particularly odontocetes, are highly social animals that spend much of their lives living in groups called "pods." The size and structures of these groups are dynamic and can range from several to several thousand individuals, depending on the species. For example, large pods numbering in the hundreds of individuals have been observed off the coast of Washington for both Pacific white-sided dolphins and Northern right whale dolphins (Adams et al., 2014). Similarly, aggregations of mysticete whales may form during particular breeding or foraging seasons, although they do not persist through time as a social unit. Marine mammals that live or travel in groups are more likely to be detected by observers, and group size characteristics are incorporated into the many density and abundance calculations. Group size characteristics are also incorporated into the Navy Acoustic Effects Model to represent a more realistic patchy distribution for the given density (U.S. Department of the Navy, 2018c; Watwood et al., 2018). The behavior of aggregating into groups is also important for the purposes of mitigation and monitoring since animals that occur in larger groups have an increased probability of being detected. A comprehensive and systematic review of relevant literature and data was conducted for available published and unpublished literature, including journals, books, technical reports, cruise reports, and raw data from cruises, theses, and dissertations. The results of this review were compiled into a Technical Report and include tables of group size information by species along with relevant citations (Watwood et al., 2018).

3.4.1.4 Habitat Use

Marine mammals occur in every marine environment in the Study Area including the narrow passage found in Alaska's Behm Canal, the inland water area of the Salish Sea, and the coastal waters to open ocean environments of the Pacific offshore of Washington, Oregon, and Northern California. Their distribution is influenced by many factors, primarily patterns of major ocean currents, bottom relief, and water temperature, which, in turn, affect prey distribution and productivity. The continuous movement of water from the ocean bottom to the surface creates a nutrient-rich, highly productive environment for marine mammal prey (Jefferson et al., 2015) and especially in zones such as the semi-permanent eddy offshore of the Strait of Juan de Fuca (Hickey & Banas, 2003; MacFadyen et al., 2008; Tolimieri et al., 2015). This oceanographic feature makes it one of the most productive habitats in the Northeastern Pacific (Menza et al., 2016).

While most baleen whales are migratory, some species such as gray whales have been documented with an undetermined small number present within the Study Area year round (Cogan, 2015; Emmons et al., 2017; Emmons et al., 2019b). Many of the toothed whales do not migrate in the strictest sense, but some do undergo seasonal shifts in distribution both within and outside of the Study Area. Pinnipeds in the Study Area occur in coastal habitats, in waters over the continental shelves, and some migrate through the mid-ocean as far north as islands in the Bering Sea or as far south Guadalupe Island off Mexico. Sea otters are generally found nearshore and require land or very shallow coastal waters as habitat for reproducing, resting, and feeding.

In 2011, NOAA convened a working group to map cetacean density and distribution within U.S. waters (Ferguson et al., 2015b; National Oceanic and Atmospheric Administration, 2019b). The specific objective of the Cetacean Density and Distribution Mapping Working Group was to create comprehensive and easily accessible regional cetacean density and distribution maps that are time and species specific. Separately, to augment this more quantitative density and distribution mapping and provide additional context for marine mammal impact analyses, the Cetacean Density and Distribution Mapping Working Group also identified (through literature search, using data from surveys, habitat modeling, compilation of the best available science, and expert elicitation) areas of importance for cetaceans, such as reproductive areas, feeding areas, migratory corridors, and areas in which small or resident populations are located. Areas identified through this process have been termed biologically important areas (Ferguson et al., 2015b; Van Parijs, 2015; Van Parijs et al., 2015). The stated intention is to serve as a resource management tool. These biologically important areas were not meant to define exclusionary zones or serve as sanctuaries or marine protected areas, and have no direct or immediate regulatory consequences (see Ferguson et al. (2015b) regarding the envisioned purpose for the biologically important area designations). The identification of biologically important areas is intended to be a "living" reference based on the best available science at the time, which will be maintained and updated as new information becomes available. As new empirical data are gathered, these referenced areas can be calibrated to determine how closely they correspond to reality of the species' habitat uses and updated as necessary (see for example National Oceanic and Atmospheric Administration (2019b), Harvey et al. (2017), and Dalla-Rosa et al. (2012)). Additionally, biologically important areas identified in the Study Area (Calambokidis et al., 2015) do not represent the totality of important habitat throughout the marine mammals' full range. The currently identified boundaries should be considered dynamic and subject to change based on new information, as well as "existing density estimates, range-wide distribution data, information on population trends and life history parameters, known threats to the population, and other relevant information" (Van Parijs, 2015).

Products of the initial assessment process, including Alaska and the U.S. West Coast biologically important areas, were compiled and published in March 2015 (Aquatic Mammals, 2015; Calambokidis et al., 2015; Ferguson et al., 2015b; Ferguson et al., 2015c). Analysis and review of these biologically important areas within the Study Area were previously reviewed and assessed by the Navy in the 2015 NWTT Final EIS/OEIS (U.S. Department of the Navy, 2015a), evaluated by NMFS in the issuance of the current Letter of Authorization pursuant to the MMPA (National Oceanic and Atmospheric Administration, 2015b), and reviewed by NMFS pursuant to ESA for listed species in the NWTT Study Area (National Marine Fisheries Service, 2014). Additional details regarding the designated biologically important areas in the Study Area are provided in the applicable species subsections that follow.

3.4.1.5 Dive Behavior

All marine mammals, with the exception of polar bears, spend part of their lives underwater while traveling or feeding. Some species of marine mammals have developed specialized adaptations to allow them to make deep dives lasting over an hour, primarily for the purpose of foraging on deep-water prey such as squid. Other species spend the majority of their lives close to the surface, and make relatively shallow dives. The diving behavior of a particular species or individual has implications for the ability to visually detect them for mitigation and monitoring. In addition, their relative distribution through the water column based on diving behavior is an important consideration when conducting acoustic effects modeling. Information and data on diving behavior for each species of marine mammal were compiled and summarized in a technical report (U.S. Department of the Navy, 2017c) that provides the detailed summary of time at depth.

3.4.1.6 Hearing and Vocalization

The typical terrestrial mammalian ear (which is ancestral to that of marine mammals) consists of an outer ear that collects and transfers sound to the tympanic membrane and then to the middle ear (Fay & Popper, 1994; Rosowski, 1994). The middle ear contains ossicles that amplify and transfer acoustic energy to the sensory cells (called hair cells) in the cochlea, which transforms acoustic energy into electrical neural impulses that are transferred by the auditory nerve to high levels in the brain (Møller, 2013). All marine mammals display some degree of modification to the terrestrial ear; however, there are differences in the hearing mechanisms of marine mammals with an amphibious ear versus those with a fully aquatic ear (Wartzok & Ketten, 1999). Marine mammals with an amphibious ear include the marine carnivores: pinnipeds, sea otters, and polar bears (Ghoul & Reichmuth, 2014b; Owen & Bowles, 2011; Reichmuth et al., 2013). Outer ear adaptations in this group include external pinnae (ears) that are reduced or absent, and in the pinnipeds, cavernous tissue, muscle, and cartilaginous valves seal off water from entering the auditory canal when submerged (Wartzok & Ketten, 1999). Marine mammals with the fully aquatic ear (cetaceans and sirenians) use bone and fat channels in the head to conduct sound to the ear; while the auditory canal still exists, it is narrow and sealed with wax and debris, and external pinnae are absent (Castellini et al., 2016; Ketten, 1998).

The most accurate means of determining the hearing capabilities of marine mammal species are direct measurements of auditory system sensitivity (Nachtigall et al., 2000; Supin et al., 2001). Studies using these methods produce audiograms—plots describing hearing threshold (the quietest sound a listener can hear) as a function of frequency. Marine mammal audiograms, like those of terrestrial mammals, typically have a "U-shape," with a frequency region of best hearing sensitivity at the bottom of the "U" and a progressive decrease in sensitivity outside of the range of best hearing (Fay, 1988; Mooney et al., 2012; Nedwell et al., 2004; Reichmuth et al., 2013). The "gold standard" for producing audiograms is the use of behavioral (psychophysical) methods, where marine mammals are trained to respond to acoustic stimuli (Nachtigall et al., 2000). For species that are untrained for behavioral psychophysical procedures, those that are difficult to house under human care, or in stranding rehabilitation and temporary capture contexts, auditory evoked potential methods are used to measure hearing sensitivity (e.g., Castellote et al., 2014; Finneran et al., 2009; Montie et al., 2011; Mulsow et al., 2011; Nachtigall et al., 2008; Nachtigall et al., 2007; Supin et al., 2001). For odontocetes, the procedure for determining audiograms through auditory evoked potential methods has recently been standardized (American National Standards Institute & Acoustical Society of America, 2018).

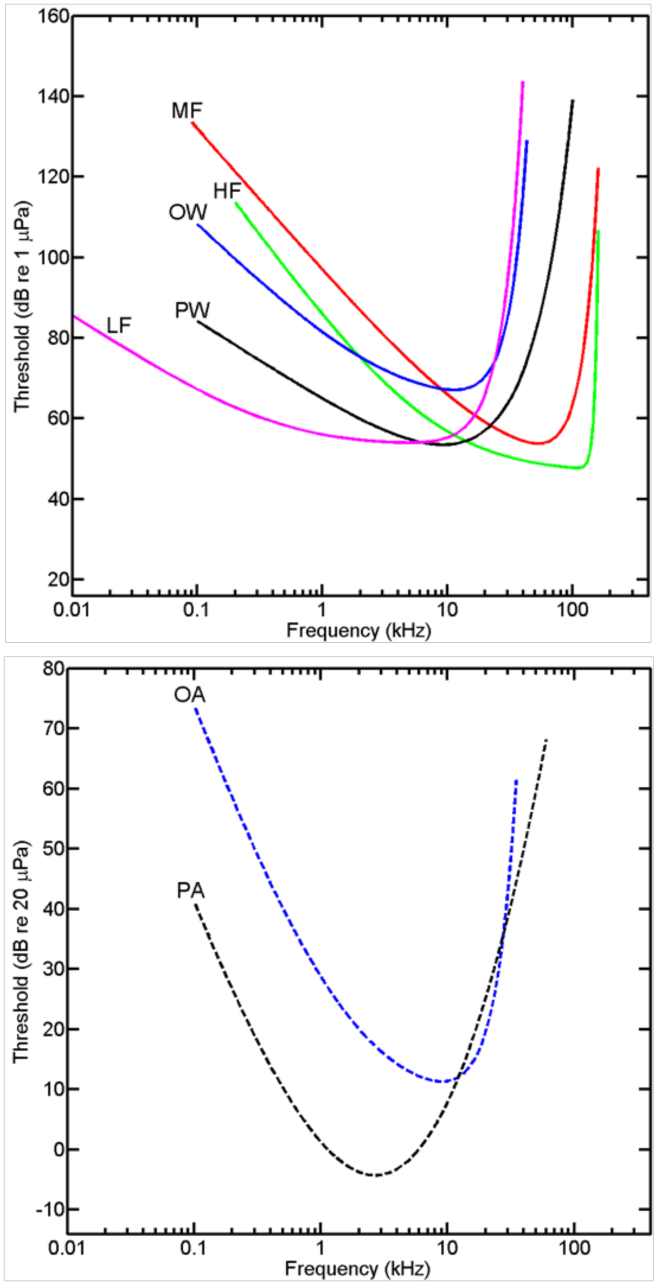
These auditory evoked potential methods, which measure electrical potentials generated by the auditory system in response to sound and do not require the extensive training needed for psychophysical methods, can provide an efficient estimate of hearing sensitivity (Finneran & Houser, 2006; Schlundt et al., 2007; Yuen et al., 2005). The thresholds provided by auditory evoked potential methods are, however, typically elevated above behaviorally measured thresholds, and auditory evoked potential methods are not appropriate for estimating hearing sensitivity at frequencies much lower than the region of best hearing sensitivity (Finneran, 2015; Finneran et al., 2016). For marine mammal species for which access is limited and therefore psychophysical or auditory evoked potential testing is impractical (e.g., mysticete whales and rare species), some aspects of hearing can be estimated from anatomical structures, frequency content of vocalizations, and extrapolations from related species.

Direct measurements of hearing sensitivity exist for approximately 25 of the nearly 130 species of marine mammals. Table 3.4-2 summarizes hearing capabilities for marine mammal species in the study area. For this analysis, marine mammals are arranged into the following functional hearing groups based on their generalized hearing sensitivities: high-frequency cetaceans (HF group: porpoises, Kogia spp.), mid-frequency cetaceans (MF group: delphinids, beaked whales, sperm whales), low-frequency cetaceans (LF group: mysticetes), otariids and other non-phocid marine carnivores in water and air (OW and OA groups: sea lions, otters), and phocids in water and air (PW and PA groups: true seals). Note that the designations of high-, mid-, and low-frequency cetaceans are based on relative differences of sensitivity between groups, as opposed to conventions used to describe active sonar systems.

Table 3.4-2: Species Within Marine Mammal Hearing Groups Likely Found in the Study Area

Hearing Group	*Species within the Study Area*
High-frequency cetaceans	Dall's porpoise
	Dwarf sperm whale
	Harbor porpoise
	Pygmy sperm whale
Mid-frequency cetaceans	Baird's beaked whale
	Common bottlenose dolphin
	Cuvier's beaked whale
	Killer whale
	Mesoplodont beaked whales
	Northern right whale dolphin
	Pacific white-sided dolphin
	Risso's dolphin
	Short-beaked common dolphin
	Short-finned pilot whale
	Sperm whale
	Striped dolphin
Low-frequency cetaceans	Blue whale
	Fin whale
	Gray whale
	Humpback whale
	Minke whale
	North Pacific right whale
	Sei whale
Otariids and other non-phocid marine carnivores	California sea lion
	Guadalupe fur seal
	Northern fur seal
	Northern sea otter
	Steller sea lion
Phocids	Harbor seal
	Northern elephant seal

For Phase III analyses, a single representative composite audiogram (Figure 3.4-1) was created for each functional hearing group using audiograms from published literature. For discussion of all marine mammal functional hearing groups and their derivation see technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects (Phase III)* (U.S. Department of the Navy, 2017b). These auditory composite audiograms were recently published by Southall et al. (2019b). The mid-frequency cetacean composite audiogram is consistent with behavioral audiograms of killer whales (Branstetter et al., 2017a) and audiograms of healthy wild belugas obtained via auditory evoked potential methods (Mooney et al., 2018) that were published following development of the technical report. The high-frequency cetacean composite audiogram is consistent with behavioral audiograms of harbor porpoises (Kastelein et al., 2017b) published after the technical report.



Source: *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017)

Notes: For hearing in water (top) and in air (bottom, phocids and otariids only). LF = low-frequency, MF = mid-frequency, HF = high-frequency, OW = otariids and other non-phocid marine carnivores in water, PW = phocids in water, OA = otariids and other non-phocid marine carnivores in air, PA = phocids in air

Figure 3.4-1: Composite Audiograms for Hearing Groups Likely Found in the Study Area

Few field studies aim to determine the hearing range of low-frequency cetaceans. However, Frankel and Stein (2020) exposed migrating gray whales to moored-source IMAPS sonar transmissions in the 21–25 kilohertz (kHz) frequency band (estimated RL = 148 decibels referenced to 1 micropascal squared [dB re 1 µPa^2]) and showed that whales moved closer inshore when the vessel range was 1–2 km during sonar transmissions. The authors conclude that gray whales can hear up to 21 kHz. This evidence supports the mysticete hearing range extending up to 30 kHz, as reflected in the LF cetacean composite audiogram estimated by Southall et al. (2019b) and the Navy (U.S. Department of the Navy, 2017b).

Lastly, the otariid and phocid composite audiograms are consistent with recently published behavioral audiograms (Cunningham & Reichmuth, 2015; Kastelein et al., 2019b).This recent work shows that phocid detection thresholds are around 4 decibels (dB) lower for longer-duration sounds with harmonics than shorter-duration tonal sounds without harmonics (Kastelein et al., 2019b), and pinniped hearing sensitivity at frequencies and thresholds far above the range of best hearing may drop off at a slower rate than previously predicted (Cunningham & Reichmuth, 2015).

Research has shown that hearing in bottlenose dolphins is directional (i.e., the relative angle between the sound source location and the dolphin affects the hearing threshold) (Accomando et al., 2020; Au & Moore, 1984). Hearing sensitivity becomes more directional as the sound frequency increases, with the greatest sensitivity to sounds presented in front and below the dolphin. Other odontocete species with less elongated skull anatomy than the bottlenose dolphin also exhibit direction-dependent hearing, but to a lesser degree (Kastelein et al., 2005a; Popov & Supin, 2009). Byl et al. (2019) showed that harbor seals likely have well-developed directional hearing for biologically relevant sounds (Section 3.4.2.1.1.4, Masking).

Similar to the diversity of hearing capabilities among species, the wide variety of acoustic signals used in marine mammal communication (including biosonar or echolocation) is reflective of the diverse ecological characteristics of cetacean, sirenian, and carnivore species (see Avens, 2003; Richardson et al., 1995b). This makes a succinct summary difficult (see Richardson et al., 1995b; Wartzok & Ketten, 1999 for thorough reviews); however, a division can be drawn between lower frequency communication signals that are used by marine mammals in general, and the specific, high-frequency biosonar signals that are used by odontocetes to sense their environment.

Non-biosonar communication signals span a wide frequency range, primarily having energy up into the tens of kHz range. Of particular note are the very low-frequency calls of mysticete whales that range from tens of hertz (Hz) to several kilohertz, and have source levels of 150–200 decibels referenced to 1 micropascal (dB re 1 µPa) (Cummings & Thompson, 1971; Edds-Walton, 1997; Širović et al., 2007; Stimpert et al., 2007; Wartzok & Ketten, 1999). These calls most likely serve social functions such as mate attraction, but may serve an orientation function as well (Green, 1994; Green et al., 1994; Richardson et al., 1995b). Humpback whales are a notable exception within the mysticetes, with some calls exceeding 10 kHz (Zoidis et al., 2008).

Odontocete cetaceans and marine carnivores use underwater communicative signals that, while not as low in frequency as those of many mysticetes, likely serve similar functions. These include tonal whistles in some odontocetes and the wide variety of barks, grunts, clicks, sweeps, and pulses of pinnipeds. Of additional note are the aerial vocalizations that are produced by pinnipeds, otters, and polar bears. Again, the acoustic characteristics of these signals are quite diverse among species, but can be generally classified as having dominant energy at frequencies below 20 kHz (Richardson et al., 1995b; Wartzok & Ketten, 1999).

Odontocete cetaceans generate short-duration (50–200 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 & 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 (Madsen et al., 2005; Villadsgaard et al., 2007).

In general, frequency ranges of vocalization lie within the audible frequency range for an animal (i.e., animals vocalize within their audible frequency range); however, auditory frequency range and vocalization frequencies do not perfectly align. For example, odontocete echolocation clicks contain a broad range of frequencies, and not all of the frequency content is necessarily heard by the individual that emitted the click. The frequency range of vocalization in a species can therefore be used to infer some characteristics of their auditory system; however, caution must be taken when considering vocalization frequencies alone in predicting the hearing capabilities of species for which no data exist (i.e., mysticetes). It is important to note that aspects of vocalization and hearing sensitivity are subject to evolutionary pressures that are not solely related to detecting communication signals. For example, hearing plays an important role in detecting threats (e.g., Deecke et al., 2002), and high-frequency hearing is advantageous to animals with small heads in that it facilitates sound localization based on differences in sound levels at each ear (Heffner & Heffner, 1982). This may be partially responsible for the difference in best hearing thresholds and dominant vocalization frequencies in some species of marine mammals (e.g., Steller sea lions, Mulsow & Reichmuth, 2010).

3.4.1.7 General Threats

Marine mammal populations can be influenced by various natural factors as well as human activities. There can be direct effects, such as from disease, hunting, and whale watching, or indirect effects such as through reduced prey availability or lowered reproductive success of individuals. Research presented in Twiss and Reeves (1999) and National Marine Fisheries Service (2011a, 2011b, 2011d, 2011e) provides a general discussion of marine mammal conservation and the threats they face. As detailed in National Marine Fisheries Service (2011c), investigations of stranded marine mammals are undertaken to monitor threats to marine mammals and out of concerns for animal welfare and ocean stewardship. Investigations into the cause of death for stranded animals can also provide indications of the general threats to marine mammals in a given location (Ashley et al., 2020; Barcenas De La Cruz et al., 2017; Bradford & Lyman, 2015; Carretta et al., 2016b; Helker et al., 2015a). For the marine mammal populations present in the NWTT Study Area, data regarding human-caused mortality and injury to NMFS-managed stocks is available in a NMFS Technical Memorandum for marine mammal stocks in Alaska (Delean et al., 2020; Helker et al., 2019) and for stocks present on the U.S. West Coast (Carretta et al., 2019a). The known serious injury and mortalities resulting from non-Navy human activities these reports summarize are important context in reviewing the analysis of potential impacts that may result from the continuation of Navy training and testing in the NWTT Study Area.

The causes for strandings include infectious disease, parasite infestation, reduced prey availability leading to starvation, pollution exposure, trauma (e.g., injuries from ship strikes or fishery entanglements), sound (human-generated or natural), harmful algal blooms and associated biotoxins, and ingestion or interaction with marine debris (for more information see NMFS Marine Mammal Stranding Response Fact Sheet; (National Marine Fisheries Service, 2016b). For a general discussion of strandings and their causes as well as strandings in association with U.S. Navy activity, see the technical report titled *Strandings Associated with U.S. Navy Activity* (U.S. Department of the Navy, 2017e).

3.4.1.7.1 Water Quality

Chemical pollution and impacts on ocean water quality is of great concern, although its effects on marine mammals are just starting to be understood (Bachman et al., 2015; Bachman et al., 2014; Desforges et al., 2016; Foltz et al., 2014; Gaydos, 2010; Godard-Codding et al., 2011; Hansen et al., 2015; Jepson & Law, 2016; Law, 2014; Peterson et al., 2015; Peterson et al., 2014; Ylitalo et al., 2009; Ylitalo et al., 2005). Oil and other chemical spills are a specific type of ocean contamination that can have damaging effects on some marine mammal species directly through exposure to oil or chemicals and indirectly due to pollutants' impacts on prey and habitat quality (Engelhardt, 1983; Marine Mammal Commission, 2010; Matkin et al., 2008). In the five-year period from 2013 to 2017 along the Pacific coast, there were 127 pinnipeds found stranded with a serious injury or mortality caused by oil or tar coating their body (Carretta et al., 2019a).

On a broader scale ocean contamination resulting from chemical pollutants inadvertently introduced into the environment by industrial, urban, and agricultural use is also a concern for marine mammal conservation and has been the subject of numerous studies (Cossaboon et al., 2019; Desforges et al., 2016; Fair et al., 2010; Krahn et al., 2007; Krahn et al., 2009; Moon et al., 2010; Ocean Alliance, 2010). For example, the chemical components of pesticides used on land flow as runoff into the marine environment, which can accumulate in the bodies of marine mammals, and be transferred to their nursing young through mother's milk (Fair et al., 2010; Gaydos, 2010). The presence of these chemicals in marine mammals has been assumed to put those animals at greater risk for adverse health effects and potential impact on their reproductive success given toxicology studies and results from laboratory animals (Fair et al., 2010; Godard-Codding et al., 2011; Krahn et al., 2007; Krahn et al., 2009; Peterson et al., 2015; Peterson et al., 2014). Desforges et al. (2016) have suggested that exposure to chemical pollutants may act in an additive or synergistic manner with other stressors, resulting in significant population-level consequences. Although the general trend has been a decrease in chemical pollutants in the environment following their regulation, chemical pollutants remain important given their potential to impact marine mammals and marine life in general (Bonito et al., 2016; Cossaboon et al., 2019; Jepson & Law, 2016; Law, 2014).

3.4.1.7.2 Bycatch

Fishery bycatch is likely the most impactful threat to marine mammal individuals and populations and may account for the deaths of more marine mammals than any other cause (Carretta et al., 2019a; Carretta et al., 2019b; Carretta et al., 2017a; Carretta et al., 2016b; Geijer & Read, 2013; Hamer et al., 2010; Helker et al., 2017; Lent & Squires, 2017; National Marine Fisheries Service, 2016c; Northridge, 2009; Read, 2008). In 1994, the MMPA was amended to formally address bycatch by U.S. Fisheries. The amendment requires the development of a take reduction plan when bycatch exceeds a level considered unsustainable and will lead to marine mammal population decline. In addition, NMFS develops and implements take reduction plans that help recover and prevent the depletion of strategic stocks of marine mammals that interact with certain fisheries.

At least in part as a result of the amendment, estimates of bycatch in the Pacific declined by a total of 96 percent from 1994 to 2006 (Geijer & Read, 2013). Cetacean bycatch declined by 85 percent from 342 in 1994 to 53 in 2006, and pinniped bycatch declined from 1,332 to 53 over the same time period.

3.4.1.7.3 Entanglement and Other Fishery Interactions

Fishery interactions other than bycatch include entanglement from abandoned or partial nets, fishing line, hooks, and the ropes and lines connected to fishing gear (Barcenas De La Cruz et al., 2017;

California Coastal Commission, 2018; California Ocean Protection Council & National Oceanic and Atmospheric Administration Marine Degree Program, 2018; Carretta et al., 2019a; Carretta et al., 2017b; Currie et al., 2017b; Delean et al., 2020; Díaz-Torres et al., 2016; Fisheries and Oceans Canada, 2019; Helker et al., 2019; Helker et al., 2017; Kuzin & Trukhin, 2019; Lowry et al., 2018; National Marine Fisheries Service, 2018d; National Oceanic and Atmospheric Administration, 2016a, 2018d, 2020b; National Oceanic and Atmospheric Administration Marine Debris Program, 2014a; Polasek et al., 2017; Saez, 2018; Saez et al., 2020; Santora et al., 2020; Scordino et al., 2020). The National Oceanic and Atmospheric Administration Marine Debris Program (2014b) reports that abandoned, lost, or otherwise discarded fishing gear constitutes the vast majority of mysticete entanglements. For Alaska between 2013 and 2017, there were 334 fishery-related serious injuries or mortalities (Helker et al., 2019); and for the U.S. West Coast during the same period, there were 1,043 cases of fishery-related entanglements (Carretta et al., 2019a). In 2014 off Grays Harbor, a humpback whale was successfully dis-entangled from crab pot fishing gear (Calambokidis, 2014). In May 2017, a gray whale calf was discovered dead onshore near the mouth of the Columbia River after becoming entangled in crab pot fishing gear (Cascadia Research, 2017a). NMFS has identified incidental catches in coastal net fisheries off Japan, Korea, and northeastern Sakhalin Island as a significant threat to endangered Western North Pacific gray whales (Carretta et al., 2019c; Carretta et al., 2018a; Lowry et al., 2018). Species or large whales found entangled off the U.S. West Coast in 2015 and 2016 included stocks that are present in the Study Area such as humpback, gray, blue, fin, and killer whales, with a total of 133 entanglements in the two-year period (National Marine Fisheries Service, 2018d; National Oceanic and Atmospheric Administration, 2017). In the most recent five-year reporting period for Alaska and the U.S. West Coast, most humpback whale injuries and mortality were from entanglements in fishing gear totaling 169 known occurrences (Carretta et al., 2019a; Helker et al., 2019). For the large whales along the U.S. West Coast in 2018, there were reports of entangled animals involving 34 humpbacks, 11 gray whales, 1 fin whale, 1 blue whale, and 2 animals that were unidentified (National Oceanic and Atmospheric Administration, 2019a). For the identified sources of entanglement in these NMFS reports, none included Navy expended materials.

Along the U.S. West Coast, hook and line entanglements and gunshot wounds are two of the primary causes of pinniped injuries found in strandings (Barcenas De La Cruz et al., 2017; Carretta et al., 2019a; Carretta et al., 2016b; Carretta et al., 2013b; National Oceanic and Atmospheric Administration, 2018c; Seal Sitters Marine Mammal Stranding Network, 2018; Warlick et al., 2018). In Alaska between 2012 and 2016, the entanglement in or ingestion of fishery gear resulted in a total of 117 serious injuries to Steller sea lions (Helker et al., 2019; Helker et al., 2017). For Alaska between 2012 and 2016, there were 96 marine mammals found with gunshot wounds (Helker et al., 2019) and for the U.S. West Coast between 2013 and 2017, there were 199 known cases of marine mammals being shot (Carretta et al., 2019a). In Washington and Oregon between 2002 and 2016, gunshot wounds, fisheries entanglements, and boat collisions were the leading causes of identified human interactions with pinnipeds found stranded (Warlick et al., 2018); these interactions involved all pinniped species that are present in the NWTT Study Area. Along the coast (Warlick et al., 2018), most of the reported pinniped strandings were centered at the Columbia River or Newport, Oregon, which are both far to the south of where most Navy training and testing occurs. In December 2018, due to the prevalence of known pinniped shootings, NOAA Fisheries was working on publishing guidelines for fishermen who take actions to deter pinnipeds and other marine mammals from their catch (National Oceanic and Atmospheric Administration, 2018c, 2019c).

In waters off Alaska, Washington, and California, passive acoustic monitoring efforts since 2009 have documented the routine use of non-military explosives at-sea (Baumann-Pickering et al., 2013; Debich et al., 2014; Kerosky et al., 2013; Rice et al., 2015b; Trickey et al., 2015; Wiggins et al., 2019). Based on the spectral properties of the recorded sounds and their correspondence with known fishing seasons or activity, the source of these explosions has been linked to the use of explosive marine mammal deterrents, which as a group are commonly known as "seal bombs" (Baumann-Pickering et al., 2013; Bland, 2017; Klint, 2016; Wiggins et al., 2019). Seal bombs are intended to be used by commercial fishers to deter marine mammals, particularly pinnipeds, from preying upon their catch and to prevent marine mammals from interacting and potentially becoming entangled with fishing gear (National Marine Fisheries Service, 2015b).

Based on the number of explosions recorded over the past several years in Alaska, Washington, and Southern California (Baumann-Pickering et al., 2013; Bland, 2017; Emmons et al., 2019b; Oleson & Hildebrand, 2012; Trickey et al., 2015; Wiggins et al., 2019), the use of seal bombs is much more prevalent than might be expected. For example, in mid-late June 2012 at one monitoring site adjacent to Quinault Canyon (off the coast of Washington) these explosions identified as seal bombs were present during daylight hours 68 percent of the cumulative hours per week (Wiggins et al., 2017). The prevalent and continued use of seal bombs seems to indicate that, while a potential threat, their use has had no significant effect on populations of marine mammals given that it is likely at least some individuals, if not larger groups of marine mammals, have been repeatedly exposed to this explosive stressor.

Since 2010, the Oregon Department of Fish & Wildlife and Washington Department of Fish & Wildlife have conducted a removal program for California sea lions that prey on ESA-listed Chinook salmon and steelhead stocks at Bonneville Dam (Schakner et al., 2016). Although non-lethal pyrotechnic and rubber buckshot are used as short-term deterrents, in 2016 (for example), they lethally removed (i.e., euthanized) 59 California sea lions (Madson et al., 2017). In December 2018, Congress signed into law the Endangered Salmon Predation Prevention Act that allows NMFS to authorize the intentional lethal taking of California sea lions on the waters of the Columbia River and its tributaries for the protection of endangered salmon. In the five-year period from 2013 to 2017, there were 124 pinniped "removals" for that purpose (Carretta et al., 2019a).

3.4.1.7.4 Noise

In some locations, especially like the NWTT Study Area, where urban or industrial activities or commercial shipping is intense, anthropogenic noise can be a potential habitat-level stressor (Cominelli et al., 2018; Dunlop, 2016; Dyndo et al., 2015; Erbe et al., 2019; Erbe et al., 2014; Frisk, 2012; Gedamke et al., 2016; Haver et al., 2018; Haxell et al., 2019; Hermannsen et al., 2014; Hermannsen et al., 2019; Joy et al., 2019; Li et al., 2015; MacGillivray et al., 2019; McKenna et al., 2012; Melcón et al., 2012; Miksis-Olds & Nichols, 2016; Nowacek et al., 2015; Pine et al., 2016; Southall et al., 2018; Sullivan & Torres, 2018; Williams et al., 2014c; Williams et al., 2019; Wisniewska et al., 2018; Wladichuk et al., 2019). The Strait of Juan de Fuca serves as the entrance to multiple ports in both U.S. and Canadian waters and is transited by approximately 8,300 deep draft vessels annually, excluding passenger vessel counts (Haxell et al., 2019; Van Dorp & Merrick, 2017). Noise is of particular concern to marine mammals because many species use sound as a primary sense for navigating, finding prey, avoiding predators, and communicating with other individuals. Noise may cause marine mammals to leave a habitat, impair their ability to communicate, or cause physiological stress (Burnham & Duffus, 2019; Cholewiak et al., 2018; Courbis & Timmel, 2008; Erbe, 2002; Erbe et al., 2019; Erbe et al., 2016; Hildebrand, 2009; Holt et al., 2017; Putland et al., 2018; Rolland et al., 2012; Southall et al., 2018; Tyack et al., 2011; Tyne et al., 2017; Wieland et al., 2010; Williams et al., 2014b; Williams et al., 2019; Wisniewska et al., 2018). Noise can cause behavioral disturbances, mask other sounds including their own vocalizations, may result in injury, and in some cases may result in behaviors that ultimately lead to death (Erbe et al., 2019; Erbe et al., 2016; Erbe et al., 2014; National Research Council, 2003, 2005; Nowacek et al., 2007; Southall et al., 2009; Tsujii et al., 2018; Tyack, 2009; Würsig & Richardson, 2009). Anthropogenic noise is generated from a variety of sources including commercial shipping, oil and gas exploration and production activities, commercial and recreational fishing (including fish-finding sonar, fathometers, and acoustic deterrent and harassment devices), foreign navies, recreational boating and whale watching activities, offshore power generation, and research (including sound from air guns, sonar, and telemetry). Whale watching noise and associated disturbance of cetaceans is a growing concern in the waters of the Study Area and other locations (Burnham & Duffus, 2019; Cholewiak et al., 2018; Di Clemente et al., 2018; Ferrara et al., 2017; Gabriele et al., 2018; Giles & Koski, 2012; Hermannsen et al., 2019; Holt et al., 2017; Houghton et al., 2015b; Lacy et al., 2017; Machernis et al., 2018; National Marine Fisheries Service, 2018e; Putland et al., 2018; Schuler et al., 2019; Seely et al., 2017; Sullivan & Torres, 2018; Tollit et al., 2017; Tyne et al., 2018; Veirs et al., 2016; Wladichuk et al., 2018; Wladichuk et al., 2019; Zapetis et al., 2017). Whale watching in the Salish Sea increased significantly from a few boats in the 1970s to an estimated 96 active commercial whale watching vessels operating in 2015 (Seely et al., 2017).

Commercial vessel noise in particular is a major contributor to noise in the ocean and intensively used inland waters containing major ports, such as the NWTT Study Area (Bassett et al., 2012; Cates & Acevedo-Gutiérrez, 2017; Cominelli et al., 2018; Erbe et al., 2012; Erbe et al., 2016; Erbe et al., 2014; Frisk, 2012; Hildebrand, 2004, 2009; Holt et al., 2017; Joy et al., 2019; MacGillivray et al., 2019; Miksis-Olds & Nichols, 2016; Oleson & Hildebrand, 2012; Seely et al., 2017; Southall et al., 2018; Tollit et al., 2017; Williams et al., 2019). As provided in more detail in Section 3.12.2.1.1 (Ocean Traffic), large commercial vessels using the Strait of Juan de Fuca for visits to just the three ports of Vancouver, Seattle, and Tacoma, make approximately 7,000 transits per year through the NWTT Study Area (Office of the Washington Governor, 2018; The Northwest Seaport Alliance, 2018; U.S. Maritime Administration, 2016; Van Dorp & Merrick, 2017; Vancouver Fraser Port Authority, 2017).

For the Inland Waters portion of the Study Area, in 2008 there was a 24-hour average of three vessels per hour present in the Strait of Juan de Fuca and Haro Strait (Erbe et al., 2014). In 2017 over a two-month period, there were 951 large vessel[1] transits through Haro Strait, for an average of over 15 large ships per day or 450 per month (Vancouver Fraser Port Authority, 2018). In addition to the approximately 7,000 commercial vessel transits to ports of Vancouver, Seattle, and Tacoma, the 23 Washington state ferries make almost 450 transits per day (Washington State Department of Transportation, 2018), equivalent to approximately 164,000 transits per year, that contribute to underwater ambient noise in the Inland Waters. The Washington State Governor's Southern Resident Orca Task Force has noted that Washington state ferries are by far the largest contributor to underwater noise in Puget Sound because of the sheer volume of multi daily transits throughout the Inland Waters portion of the NWTT Study Area (Office of the Washington Governor, 2018). Also needing consideration

[1] Large in this context refers to piloted commercial vessels. BC Coast Pilots embark and guide every commercial vessel that is over 350 gross tonnes, and every pleasure craft over 500 gross tonnes in British Columbia's coastal waters, including the waters of Haro Strait located north of the Inland waters portion of the NWTT Study Area.

but absent from most summaries of vessel traffic is the noise from a presumably large number[2] of recreational small boats (Erbe et al., 2014; Mikkelsen et al., 2019; Wladichuk et al., 2018; Wladichuk et al., 2019).

In contrast to the approximate 171,000 commercial vessel transits in the Inland Waters portion of the NWTT Study Area, Navy vessels are projected to undertake approximately 240 transits per year for training and testing activities. The 44 Navy vessels homeported in the NWTT Study Area potentially participating training and testing activities are commissioned vessels including 7 Guided Missile Destroyers, 14 submarines, 2 aircraft carriers, and 22 security vessels in addition to service craft and small boats that support homeported vessels and other activities. With the exception of the security vessels, the homeported ships and submarines are never all present at the same time given their rotating scheduled deployments, and some are otherwise unavailable for training and testing activities due to required maintenance periods. Unlike commercial vessels, Navy vessel design generally incorporates quieting technologies in propulsion components, machinery, and the hull structure to reduce radiated acoustic energy. As a result, and in addition to being approximately one-tenth of 1 percent of total vessel traffic in Inland Waters, Navy vessels when present do not add significantly to ambient noise levels, the vast majority of which results from other vessels operating in the area, as documented in numerous publications (Bassett et al., 2012; Erbe, 2002; Erbe et al., 2012; Erbe et al., 2014; Joy et al., 2019; MacGillivray et al., 2019; Office of the Washington Governor, 2018; Williams et al., 2014b; Wladichuk et al., 2018).

At Ketchikan, located to the south of Behm Canal, there were 427 port visits in 2012, with approximately 20 percent of the time per visit spent at a wilderness fjord location such as Behm Canal during a cruise season that runs between April and September (Webb & Gende, 2015). Frankel and Gabriele (2017) noted that broadband noise from cruise ships in Glacier Bay, Alaska (where vessel traffic is similar to traffic at Ketchikan), is between approximately 172 and 192 dB (re 1 µPa at 1 m). At Glacier Bay, the twice-daily cruise ship passages have been shown to impact communication between humpback whales in the area (Fournet et al., 2018). The authors note that NMFS requires ocean users elsewhere to obtain permits for activities exposing marine mammals to the sound exposure levels estimated from those cruise ships in Glacier Bay (Gabriele et al., 2018). In other locations and based on observed behavioral responses, it has been suggested that whale watching of humpback mother-calf groups should be avoided, because whale watching vessels disturb nursing and calving activities (Garcia-Cegarra et al., 2018). While similar conditions may occur near the port of Ketchikan between May and September, fewer vessels would be expected near Behm Canal.

Commercial vessel traffic in the heavily used portions of the NWTT Offshore area may also disturb marine mammals as ships transit the coast and approaches to the Strait of Juan de Fuca and the Columbia River. Redfern et al. (2017) found that shipping channels leading to and from the ports of Los Angeles and Long Beach may have degraded the habitat for blue, fin, and humpback whales due to the loss of communication space where important habitat for these species overlaps with elevated noise from commercial vessel traffic (the same population of whales affected when off Southern California also occur in the Study Area). The approaches to the Strait of Juan de Fuca can be assumed to have a similar frequency of commercial vessel traffic, given the various ports of call in Canada and the Inland Waters portion of the Study Area; therefore vessel traffic in the NWTT Offshore area is also likely to

[2] In 2019, the Recreational Boating Association of Washington had over 230,000 members (Recreational Boating Association of Washington, 2019; Washington State Recreation and Conservation Office, 2019).

impact marine mammal communication space. Acoustic monitoring at a site off Quinault has recorded boat and ship noise approximately 65–75 percent of monitored days (Oleson & Hildebrand, 2012; Trickey et al., 2015). Some of this traffic runs parallel to the coast as vessels transit to or from ports outside the NWTT Study Area and as described in Section 3.12 (Socioeconomic Resources and Environmental Justice), including additional vessel traffic to port calls within the Columbia River. For example, approximately 500 vessels arrived in Portland, Oregon, in 2015 (U.S. Maritime Administration, 2016). Vessels transiting the mouth of the Columbia River through the productive Columbia River plume (see Kaltenberg and Benoit-Bird (2018)) are in an area where Southern Resident killer whales spend the majority of their time when offshore (Hanson et al., 2018), and where other marine mammals are believed to seasonally forage (Pelland et al., 2015).

In many areas of the world, oil and gas seismic exploration in the ocean is undertaken using a group of air guns towed behind large research vessels. The airguns convert high pressure air into very strong shock wave impulses that are designed to return information off the various buried layers of sediment under the seafloor. Seismic exploration surveys last many days and cover vast overlapping swaths of the ocean area being explored. Most of the impulse energy produced by these airguns is heard as low-frequency sound, which can travel long distances and has the potential to impact marine mammals. Acoustic monitoring in Study Area off the Washington coast between June 11 and July 12, 2012 recorded seismic airgun pulses (the sounds from seismic airguns) on most days of the survey (Klinck et al., 2015). NMFS routinely issues permits for the taking of marine mammals associated with these commercial activities.

3.4.1.7.5 Hunting

Commercial hunting, as in whaling and sealing operations, provided the original impetus for marine mammal management efforts and has driven much of the early research on cetaceans and pinnipeds (Twiss & Reeves, 1999). With the enactment of the MMPA and the 1946 International Convention for the Regulation of Whaling, hunting-related mortality has decreased over the last 40 years. Unregulated harvests are still considered as direct threats; however, since passage of the MMPA, there have been relatively few serious calls for culls of marine mammals in the United States compared to other countries, including Canada (Roman et al., 2013). Review of uncovered Union of Soviet Socialist Republics catch records in the North Pacific Ocean indicate extensive illegal whaling activity between 1948 and 1979, with a harvest totaling 195,783 whales. Of these, only 169,638 were reported by the Union of Soviet Socialist Republics to the International Whaling Commission (Ilyashenko et al., 2014; Ilyashenko & Chapham, 2014; Ilyashenko et al., 2013, 2015). In July 2019, Japan withdrew from the International Whaling Commission and resumed commercial whaling within Japanese waters (BBC News, 2019; Nishimura, 2019; Victor, 2018). Japan had set an annual quota of more than 600 whales while a member of the International Whaling Commission, but the current limit now stands at 227 whales until the end of the 2019 and including 52 minke whales, 150 Bryde's whales, and 25 sei whales (Nishimura, 2019); the annual quota set for 2020 was 383 whales total (Hurst, 2020). Although the resumed commercial whaling will only take place within the Japanese EEZ waters, it is possible that some of the whales found in Japanese waters may be part of the same populations present seasonally in the NWTT Study Area.

For U.S. waters, there is a provision in the MMPA that allows for subsistence harvest of marine mammals, primarily by Alaska Natives. As discussed in the 2015 NWTT Final EIS/OEIS, the Western Behm Canal is within the Ketchikan Nonsubsistence Use Area (U.S. Department of the Navy, 2015a). Alaska state law requires identification of nonsubsistence areas that are defined as areas where,

"… dependence upon subsistence (customary and traditional uses of fish and wildlife) is not a principal characteristic of the economy, culture, and way of life" (Alaska Department of Fish and Game Division of Subsistence, 1992). Based on interviews with Alaska Natives, the State of Alaska has determined that the area surrounding the Southeast Alaska Acoustic Measurement Facility (SEAFAC) Range and Western Behm Canal is an area where there hunts or harvests of marine mammals for subsistence use did not occur (Alaska Department of Fish and Game Division of Subsistence, 1992, 2011). As a result, the State of Alaska established the Ketchikan Nonsubsistence Use Area and reaffirmed that determination in 2011 (Alaska Department of Fish and Game, 2011).

Subsistence hunting by Russia and Alaska Natives does occur in the North Pacific, Chukchi Sea, and Bering Sea, affecting marine mammal stocks that may be present in the Study Area. For example, in two years of hunting (2010 and 2011) on St. Paul Island and St. George Island in the Bering Sea there were 878 northern fur seals harvested for subsistence ((Testa, 2012)). In February 2010 near Humboldt, California (inshore of the Action Area), a stranded gray whale was found to have parts of two harpoons embedded in its body, which likely resulted from a failed hunt in Russian or Alaskan waters (Carretta et al., 2017c). In Russian waters in 2013, there were a total of 127 gray whales "struck" during subsistence whaling by the inhabitants of the Chukchi Peninsula between the Bering and Chukchi Sea (Ilyashenko & Zharikov, 2014). These gray whales harvested in Russian waters may be individuals from either the endangered Western North Pacific stock or the non-ESA listed Eastern North Pacific stock that may migrate through the NWTT Study Area. In February 2010 near Humboldt, California (inshore of the Study Area), a stranded gray whale was found to have parts of two harpoons embedded in its body, which likely resulted from a failed hunt in Russian or Alaskan waters (Carretta et al., 2017c). In 2017 at the Kuskowim River in Alaska, a gray whale was killed and harvested in what NMFS described as being an "illegal hunt" (Carretta et al., 2019a). For whales, the quotas for "aboriginal subsistence whaling" are established by the International Whaling Commission (International Whaling Commission, 2020). For example, the International Whaling Commission quotas for 2019–2025 are for a total of 980 gray whales with not more than 140 landed in any one year by native people in Chukotka (Russia) and Washington State (International Whaling Commission, 2020).

3.4.1.7.6 Vessel Strike

Ship strikes are also a growing issue for most marine mammals, although mortality may be a more significant concern for species that occupy areas with high levels of vessel traffic, because the likelihood of encounter would be greater (Cascadia Research, 2017b; Douglas et al., 2008; Greig et al., 2020; Keen et al., 2019; Moore et al., 2018; Nichol et al., 2017; Redfern et al., 2020; Redfern et al., 2019; Rockwood et al., 2017; Van der Hoop et al., 2013; Van der Hoop et al., 2015). Vessel strikes from boats and other smaller vessels can also be an issue for marine mammals in some locations (Lomac-MacNair et al., 2018; Schoeman et al., 2020).

Since 1995, the U.S. Navy and U.S. Coast Guard have reported all known or suspected vessel collisions with whales to NMFS. The assumed under-reporting of whale collisions by vessels other than U.S. Navy or U.S. Coast Guard makes any comparison of data involving vessel strikes between Navy vessels and other vessels heavily biased. This under-reporting is recognized by NMFS; for example, in the Technical Memorandum providing the analysis of the impacts from vessel collisions with whales in Hawaii (Bradford & Lyman, 2015), NMFS takes into account unreported vessel strikes by civilian vessels. Within Alaska waters, there were 28 reported marine mammal vessel strikes between 2013 and 2017 (Helker et al., 2019), and for the U.S. West Coast in the same period there were 65 reported vessel strikes to marine mammals (Carretta et al., 2019c), which is an approximate average consistent with previous reporting periods (Carretta et al., 2018c; Carretta et al., 2017b; Carretta et al., 2016b; Helker et al., 2015b; Helker et al., 2017). Strandings of cetaceans in Washington between 1980 and 2006 included 19 stranded large whales with signs of blunt force trauma or propeller wounds indicative of a vessel strike and involving fin, grey, blue, humpback, sei, and Baird's beaked whales (Douglas et al., 2008). Since 2002, 10 out of the 12 stranded fin whales in Washington have showed evidence attributed to a large ship strike (Cascadia Research, 2017b). The most recent NMFS database covering strandings in Washington and Oregon indicates that between 2000 and 2016, there were 18 known cases of whales struck by vessels presumably in the adjacent waters (National Marine Fisheries Service, 2017a). For the most recent NMFS database covering ship strikes off California, there were 14 known vessel strikes in 2018 and 11 strikes (as of June 2) in 2019 (National Marine Fisheries Service, 2019c).

3.4.1.7.7 Power Plant Entrainment

Coastal power plants use seawater as a coolant during power plant operation. Intakes into these plants can sometimes trap (i.e., entrain) pinnipeds that swim too close to the intake pipe. For the U.S. West Coast there were 120 reported pinniped mortalities from power plant entrainment (Carretta et al., 2016b) between 2010 and 2014.

3.4.1.7.8 Disease and Parasite

Just as in humans, disease affects marine mammal health and especially older animals. Occasionally disease epidemics can also injure or kill a large percentage of a marine mammal population (Keck et al., 2010; Paniz-Mondolfi & Sander-Hoffmann, 2009; Simeone et al., 2015). Recent review of odontocetes stranded along the California coast from 2000 to 2015 found evidence for morbilliviral infection in 9 of the 212 animals examined, therefore indicating this disease may be a contributor to mortality in cetaceans stranding along the California coast (Serrano et al., 2017). Brucellosis is an infectious disease caused by bacteria and Northern fur seals, Steller sea lions, and harbor seals in Alaska have been found carrying the antibodies indicative of this disease (Nymo et al., 2018). Examination of southern sea otter tissue samples have detected polyomavirus, parvovirus, and adenovirus infections in 80 percent of tested animals, suggesting endemic infection is present in the population (Siqueira et al., 2017). Infectious diseases are the primary cause of death for stranded sea otters found along the coasts of Washington and Oregon (Sato, 2018; White et al., 2018). Necropsies on 244 harbor seals stranded in the San Juan Islands between 2002 and 2018 found that 42 percent of sub-adults and adults presented primarily with clinical signs and gross lesions indicative of infectious disease (Ashley et al., 2020).

Mass die-offs of some marine mammal species have been linked to toxic algal blooms, which occurs as larger organisms consume multiple prey containing those toxins and thereby accumulating fatal doses (Lefebvre et al., 2016; Lefebvre et al., 2010; Summers, 2017). An example is domoic acid poisoning of California sea lions and northern fur seals from the diatom Pseudo-nitzschia spp. (Doucette et al., 2006; Fire et al., 2008; Lefebvre et al., 2016; Lefebvre et al., 2010; Torres de la Riva et al., 2009). A comprehensive study that sampled over 900 marine mammals across 13 species, including several mysticetes, odontocetes, pinnipeds, and mustelids in Alaska, found detectable concentrations of domoic acid in all 13 species and saxitoxin, a toxin absorbed from ingesting dinoflagellates, in 10 of the 13 species (Lefebvre et al., 2016). Algal toxins may have contributed to the stranding and mortality of 34 whales found around the islands in the western Gulf of Alaska and the southern shoreline of the Alaska Peninsula and another 16 stranded whales in British Columbia starting in May 2015–2016 (National Oceanic and Atmospheric Administration, 2016b; Rosen, 2015; Savage et al., 2017; Summers, 2017). These findings are relevant given that many of the whales in the Study Area migrate to the Gulf of Alaska and beyond to feed.

Additionally, all marine mammals have parasites that, under normal circumstances, probably do little overall harm, but under certain conditions can cause serious health problems or even death (Bull et al., 2006; Fauquier et al., 2009; Jepson et al., 2005; Miller et al., 2020). The most commonly reported parasitic infections were in sea otters from the protozoans *Sarcocystis neurona* and *Toxoplasma gondii* (Burgess et al., 2018; Simeone et al., 2015). Other parasites known to cause disease in pinnipeds and sea otters include nematodes, hookworms, lungworm, and thorny-headed worms (Miller et al., 2020; Simeone et al., 2015).

3.4.1.7.9 Climate Change

The global climate is warming and is having impacts on some populations of marine mammals (Ban et al., 2016; MacFadyen et al., 2008; National Marine Fisheries Service, 2015a, 2018f; National Oceanic and Atmospheric Administration, 2018b; Salvadeo et al., 2010; Santora et al., 2020; Shirasago-Germán et al., 2015; Simmonds & Eliott, 2009; Tulloch et al., 2018; VanWormer et al., 2019). Climate change can affect marine mammal species directly or indirectly, resulting in population-level shifts of distribution and range, shifting prey base, or harmful algal blooms that can lead to toxicity. Climate change can affect marine mammal species directly through shifts in the population distribution (Doney et al., 2012; National Marine Fisheries Service, 2018f), which may or may not result in net habitat loss (some can experience habitat gains). Sanford et al. (2019) have noted that severe marine heatwaves in the northeast Pacific in 2014–2016 triggered marine mammal mortality events, harmful algal blooms, and declines in subtidal kelp beds. In contrast, for the Pacific Northwest, Pelland et al. (2015) described general oceanographic characteristics that are thought to limit climate change exposure and provide potential climate refugia, which in the Study Area include the productive the Strait of Juan de Fuca eddy and a shelf area protected by coastal buoyancy current.

Climate change can also affect marine mammals indirectly via impacts on prey, changing prey distributions and locations, and changes in water temperature (Giorli & Au, 2017; von Biela et al., 2019). The recovery of the endangered Southern Resident killer whale is likely dependent on the availability of Chinook salmon as their primary prey (Crozier et al., 2019; Fearnbach et al., 2018; Wasser et al., 2017). A study of Northern elephant seals suggested that the tendency to revisit sites for foraging, breeding, or shelter may be of less evolutionary benefit in anomalous climate conditions and increasing environmental variability (Abrahms et al., 2017). Changes in prey can impact marine mammal foraging success, which in turn affects reproduction success and survival. Starting in January 2013, an elevated number of strandings of California sea lion pups were observed in five Southern California counties. These strandings, continuing into 2017, were declared an Unusual Mortality Event by NMFS (National Oceanic and Atmospheric Administration, 2018a, 2018b). This was the sixth Unusual Mortality Event involving California sea lions that has occurred in California since 1991. For the 2013–2017 event, NMFS biologists indicated that warmer ocean temperatures have shifted the location of prey species that are no longer adjacent to the rookeries, which thereby impacted the female sea lions' ability to find food and supply milk to their pups (National Marine Fisheries Service, 2018f; National Oceanic and Atmospheric Administration, 2018a). As a result, this confluence of natural events caused the pups to be undernourished and many were subsequently found stranded dead or emaciated due to starvation. From 2015 to 2019, an Unusual Mortality Event was declared for Guadalupe fur seals along the entire California coast because of an eight-fold increase over the average historical number of strandings (National Marine Fisheries Service, 2019a; National Oceanic and Atmospheric Administration, 2018b). The cause for the increase in strandings was the change in the prey base due to warming conditions (National Oceanic and Atmospheric Administration, 2018b). The California sea lion and Guadalupe fur seal populations that are present in the Study Area would have been affected by these events occurring in that seasonal southern part of their ranges. Starting in January 2019, an elevated number of gray whale strandings occurred along the west coast of North America from Mexico through Alaska that as of April 2020 totaled 313 known individuals, which prompted NMFS to declare those strandings an Unusual Mortality Event (National Marine Fisheries Service, 2019b; National Oceanic and Atmospheric Administration, 2020a). Lemos et al. (2020) used drone photogrammetry to assess the condition of gray whales while foraging along the Oregon coast from June to October over the three-year period between 2016 and 2018. The body condition of whales had been found to correlate with environmental changes and hypothesized prey availability in prior years, so that low upwelling years between 2016 and 2018 carried over to result in the Unusual Mortality Event starting in 2019 (Lemos et al., 2020).

Reduced rainfall associated with periodic drought has, on occasion, affected all of the Pacific Northwest (Xiao et al., 2016), resulting in streams with a reduced water flow and an increase in water temperature. Both those changing conditions impact salmon, which are the prey species for the endangered Southern Resident killer whales and critical to the species recovery (Fearnbach et al., 2018; Lacy et al., 2017). As a result, foraging during the spring in Salish Sea by Southern Resident killer whales has declined in recent years as they shift their range and forage for Chinook salmon or other prey species elsewhere in response to reduced prey availability in that historically used inland waters foraging area (Shields et al., 2018b).

Harmful algal blooms may become more prevalent in warmer ocean temperatures with increased salinity levels such that blooms will begin earlier, last longer, and cover a larger geographical range (Edwards, 2013; Moore, 2008). Warming ocean waters have been linked to the spread of harmful algal blooms into the North Pacific where waters had previously been too cold for most of these algae to thrive. The spread of the algae and associated blooms has led to disease in marine mammals in locations where algae caused diseases had not been previously known (Lefebvre et al., 2016). In 2015, a California sea lion was found to be suffering from brain damage caused by domoic acid produced by the harmful algal blooms. Animals have been found in California, Oregon, and Washington suffering from domoic acid poisoning. Ultimately impacts from global climate change may result in an intensification of current and on-going threats to marine mammals (Edwards, 2013).

Decadal fluctuations of the ocean and atmosphere over the North Pacific Ocean changes in the productivity of marine ecosystems across the Pacific Ocean (Di Lorenzo et al., 2010), and thereby affect the distribution of marine mammals. Marine mammals are also influenced on a more local level by climate-related phenomena, such as storms and other extreme weather patterns such as the 2015–2016 El Niño in the ocean off the U.S. West Coast. Indirect impacts may include altered water chemistry in estuaries (low dissolved oxygen or increased nutrient loading) causing massive fish kills (Burkholder et al., 2004), which changes prey distribution and availability for cetaceans (Stevens et al., 2006).

Habitat deterioration and loss is a major factor for almost all coastal and inshore species of marine mammals and may include such factors as depleting a habitat's prey base and the complete loss of habitat (Ayres et al., 2012; Kemp, 1996; Pine et al., 2016; Rolland et al., 2012; Smith et al., 2009; Veirs et al., 2015; Williams et al., 2014a). Many researchers predict that if oceanic temperatures continue to rise with an associated effect on marine habitat and prey availability, then either changes in foraging or life history strategies, including poleward shifts in many marine mammal species distributions, should be anticipated (Alter et al., 2010; Fleming et al., 2016; Ramp et al., 2015; Salvadeo et al., 2015; Sydeman & Allen, 1999). Poloczanska et al. (2016) analyzed climate change impact data that integrates multiple climate-influenced changes in ocean conditions (e.g., temperature, acidification, dissolved oxygen, and rainfall) to assess anticipated changes to a number of key ocean fauna across representative areas. Related to the Study Area, Poloczanska et al. (2016) included the California Current Ecosystem in their assessment. Their results predict a northward expansion in the distribution of zooplankton, fish, and squid, all of which are prey for many marine mammal species. This prediction may, for example, have been reflected by tagging efforts in July 2016 focusing on blue and fin whales that had to be shifted north to Central California waters when the majority of blue, fin, and humpback whales encountered were found to be too thin or otherwise in poor body condition in Southern California waters (Oregon State University, 2017). In Central California waters, the researchers identified good numbers of blue, fin, and humpback whales in better condition and indicative of a good feeding area that was likely to be sustained (Oregon State University, 2017).

Concerns over climate change modifying the U.S. West Coast upwelling patterns, increasing levels of hypoxia, and ocean acidification have generated targeted research and monitoring efforts at selected “Sentinel Sites” (Lott et al., 2011); the Olympic Coast National Marine Sanctuary is one of these monitored sites. There remains scientific uncertainty about how or if such changes will affect marine mammals and their prey, but acidification of the ocean could potentially impact the mobility, growth, and reproduction of calcium carbonate-forming organisms such as crustaceans and plankton, which are the direct prey of some marine mammals as well as an important part of the overall food chain in the ocean; and slightly alter the propagation of sound underwater (Lynch et al., 2018; Meyers et al., 2019; Rossi et al., 2016).

3.4.1.7.10 Marine Debris

Approximately 80 percent of marine debris in the ocean come from land-based sources (California Ocean Protection Council & National Oceanic and Atmospheric Administration Marine Degree Program, 2018; Thiel et al., 2018). In a seafloor survey off Southern California where the Navy has routinely trained and tested for decades, urban refuse (beverage cans, bottles, household items, and construction materials) constituted approximately 88 percent of the identified debris observed (Watters et al., 2010). Without improved waste management and infrastructure in underdeveloped coastal countries worldwide, the cumulative quantity of plastic waste available to enter the ocean from land is predicted to increase by an order of magnitude by 2025 (Jambeck et al., 2015). Marine debris is a global threat to marine mammals (National Oceanic and Atmospheric Administration Marine Debris Program, 2014a). A literature review by Baulch and Perry (2014), found that 56 percent of cetacean species are documented as having ingested marine debris. Comparing the Baulch and Perry review with that conducted by (Laist, 1997), the percentage of marine mammal species with documented records of entanglement in or ingestion of marine debris has increased from 43 to 66 percent over the past 18 years (Bergmann et al., 2015). Ingestion of marine debris by marine mammals is a less well-documented cause of mortality than entanglement, but it is a growing concern (Bergmann et al., 2015; Jacobsen et al., 2010; Puig-Lozano et al., 2018). Baulch and Perry (2014) found that ingestion of debris has been documented in 48 cetacean species, with rates of ingestion as high as 31 percent in some populations. Attributing cause of death to marine debris ingestion is difficult (Laist, 1997), but ingestion of plastic bags and Styrofoam has been identified as the cause of injury or death of minke whales (De Pierrepont et al., 2005) and deep-diving odontocetes, including beaked whales (Baulch & Perry, 2014), pygmy sperm whales (Sadove & Morreale, 1989; Stamper et al., 2006; Tarpley & Marwitz, 1993), and sperm whales (Jacobsen et al., 2010; Sadove & Morreale, 1989).

Marine mammals migrating in the central Pacific and through the Study Area going north to the Gulf of Alaska and beyond and heading south as far as Central America also encounter threats outside the Study

Area (Díaz-Torres et al., 2016; Gibbs et al., 2019; Thiel et al., 2018). In Alaska from 2011 through 2015, records of approximately 3,700 human-marine mammal interactions were reviewed by NMFS and determined to have resulted in 440 entanglement/entrapment-related marine mammal serious injury or mortality to various species (Helker et al., 2017). For example, between 2011 and 2015 the most common cause of serious injuries for the Eastern U.S. stock of Steller sea lions was entanglement in marine debris or fishery gear (totaling 146 sea lions) (Helker et al., 2017); for the period from 2013 to 2017 this total was 117 seriously injured Steller sea lions (Helker et al., 2019). Likely reflecting fishery practices across the north Pacific, in the Northwest Hawaiian Islands where there have been active efforts at marine debris removal since 1996, the NOAA marine debris team has removed 848 metric tons of derelict fishing nets and debris and estimates an additional 52 metric tons of derelict fishing gear collects on the shallow coral reefs and shores there every year (National Oceanic and Atmospheric Administration, 2018d).

On the U.S. West Coast for the marine mammal stocks that are present in the Study Area, marine debris resulted in mortalities to 129 marine mammals in the five-year period from 2013 to 2017 (the majority California sea lions), two gray whales, and one each of the following species: humpback whale, minke whale, bottlenose dolphin, long-beaked common dolphin, and harbor porpoise (Barcenas De La Cruz et al., 2017; Carretta et al., 2019a; Carretta et al., 2016b). From 2013 through 2017, there were 10 blue whales, 54 humpback whales, and 6 sperm whales entanglements documented for those ESA-listed species (Carretta et al., 2019a).

An estimated 75 percent or more of marine debris consists of plastic (Derraik, 2002; Hardesty & Wilcox, 2017). High concentrations of floating plastic have been reported in the central areas of the North Atlantic and Pacific Oceans (Cozar et al., 2014; Mu et al., 2019). Plastic pollution found in the oceans is primarily dominated by particles smaller than 1 centimeter, commonly referred to as microplastics (California Coastal Commission, 2018; Hidalgo-Ruz et al., 2012). Other researchers have defined microplastics as particles with a diameter ranging from a few micrometers up to 5 millimeters (mm) and are not readily visible to the naked eye (Andrady, 2015). Microplastic fragments and fibers found throughout the oceans result from the breakdown of larger items, such as clothing, packaging, and rope and have accumulated in the pelagic zone and sedimentary habitats (Thompson et al., 2004). Results from the investigation by Browne et al. (2011) have also suggested that microplastic fibers are discharged in sewage effluent resulting from the washing of synthetic fiber clothes. DeForges et al. (2014) sampled the Northeast Pacific Ocean in areas in and near the coastal waters of British Columbia, Canada, and found microplastics (those 62–5,000 micrometers in size) were abundant in all samples with elevated concentrations near urban centers, a finding that should be applicable to all urban centers such as those in the Study Area. Besseling et al. (2015) documented the first occurrence of microplastics in the intestines of a humpback whale, and while the primary cause of the stranding was not determined, the researchers found multiple types of microplastics ranging in sizes from 1 millimeter to 17 centimeters. There is still a large knowledge gap about possible negative effects of microplastics but it remains a concern (Besseling et al., 2015; Burkhardt-Holm & N'Guyen, 2019). Specifically, the propensity of plastics to absorb and concentrate dissolved pollutant chemicals, such as persistent organic pollutants, is a concern because microfauna may be able to digest plastic nanoparticles, facilitating the delivery of dissolved pollutant chemicals across trophic levels and making them bioavailable to larger marine organisms, such as marine mammals (Andrady, 2015; Burkhardt-Holm & N'Guyen, 2019).

For orientation with the geographic referents (latitude and longitude) in the following species-specific sections, refer to the depictions of the Study Area presented in Chapter 2 (Description of Proposed Action and Alternatives) in Figures 2.2-1 through 2.2-4 in this Supplemental.

Mysticetes

3.4.1.8 North Pacific Right Whale (*Eublaena japonica*)

3.4.1.8.1 Status and Management

North Pacific right whales are listed as endangered under the ESA, and this species is currently one of the most endangered whales in the world (Clapham, 2016; National Marine Fisheries Service, 2013a, 2017b; Wade et al., 2010). Critical habitat for the North Pacific right whale is located in the western Gulf of Alaska off Kodiak Island and in the southeastern Bering Sea/Bristol Bay area (Muto et al., 2017; Muto et al., 2019a); there is no designated critical habitat for this species within the Study Area. In the Alaska SAR, NMFS provides information for a single stock of North Pacific right whale designated as the Eastern North Pacific stock, although they also recognize a Western North Pacific stock that feeds east of Sakhalin Island (Muto et al., 2017; Muto et al., 2019a).

3.4.1.8.2 Abundance

The most recent abundance estimate for the eastern North Pacific right whale is between 26 and 31 individuals in the population (Muto et al., 2017; Muto et al., 2019a). Although this estimate may be reflective of a Bering Sea subpopulation, the total eastern North Pacific population is unlikely to be much larger (Muto et al., 2017; Muto et al., 2019a; Wade et al., 2010). In the North Pacific west of the International Date Line, Matsuoka et al. (2014) documented as many as 55 North Pacific right whale sightings (77 animals) between 1994 and 2013; there was an additional sighting off Hokkaido, Japan in 2017 (Matsuoka et al., 2018). The stock from which these individuals belong has not been identified but for purposes of this analysis are assumed to belong to the stock of Western North Pacific right whales.

3.4.1.8.3 Distribution

Until recently, historical whaling records provided virtually the only information on North Pacific right whale distribution (Gregr et al., 2000; National Marine Fisheries Service, 2013a; Wright et al., In press; Wright et al., 2018). This species historically occurred across the Pacific Ocean north of 35°N, with concentrations in the Gulf of Alaska, eastern Aleutian Islands, south-central Bering Sea, Okhotsk Sea, and the Sea of Japan (Crance et al., 2017; Gregr et al., 2000; Ivashchenko & Chapham, 2012; Ivashchenko et al., 2015; Scarff, 1991, 2001; Shelden et al., 2005). Right whales were probably never common along the west coast of North America (Brownell et al., 2001; Reeves & Smith, 2010; Scammon, 1874; Scarff, 1991, 2001). They are generally migratory, with at least a portion of the population moving between summer feeding grounds in temperate or high latitudes and winter calving areas in warmer waters (National Marine Fisheries Service, 2013a, 2017b). In recent years, this species has generally only been observed or acoustically detected in the Bering Sea/Bristol Bay Alaska area (Brownell et al., 2001; Crance et al., 2017; Crance et al., 2019; Rone et al., 2015; Shelden et al., 2005; U.S. Department of the Navy, 2017f; Wade et al., 2011; Wade et al., 2010; Wright et al., 2019; Wright et al., 2018; Zerbini et al., 2015; Zerbini et al., 2010), with occasional sightings in the western Gulf of Alaska area (Matsuoka et al., 2014; Širović et al., 2015a; U.S. Department of the Navy, 2017f; Wade et al., 2011). In the summer of 2018 a North Pacific right whale was documented by researchers at approximately 65° north latitude off the eastern coast of the Chukotka Peninsula, making it the northernmost sighting on record; this sighting is possibly related to an increase in global temperatures resulting in an expansion of suitable foraging habitat for the species (Filatova et al., 2019).

Offshore. The likelihood of an individual Eastern North Pacific right whale being present in the NWTT Study Area is extremely low given that they have rarely being detected in recent years south of the waters around Kodiak Alaska. There is no evidence to suggest that the western coast of the United States was ever highly frequented by this species (Brownell et al., 2001; Reeves & Smith, 2010; Scammon, 1874), although whaling records indicate a large number of North Pacific right whales taken from the Gulf of Alaska (see Rone et al. (2015)). As presented in the 2015 NWTT Final EIS/OEIS (U.S. Department of the Navy, 2015a), there have been a few sightings of right whales south of Alaska waters in the eastern Pacific in modern times. In June 2013 a single right whale was sighted in the waters off Haida Gwaii. Approximately nine days later and 200 NM to the south, a Navy-funded bottom-mounted passive acoustic monitoring device at Quinault Canyon detected two right whale calls within a two-hour period (Širović et al., 2015a). In October of that same year (2013) off the Strait of Juan de Fuca, another (different) single right whale was seen with a group of humpback whales moving south into the Offshore portion of the Study Area (U.S. Department of the Navy, 2015a). There have also been four sightings, each of a single right whale, in California waters within approximately the last 30 years (in 1988, 1990, 1992, and 2017) (Brownell et al., 2001; Carretta et al., 1994; Price, 2017). In 2017, a lone right whale was briefly observed close to shore off La Jolla Cove in Southern California (Price, 2017) and it is reasonable to assume that this individual and others sighted in California traveled through the Study Area on their way to and from Arctic waters. Based on this data, vagrant individual North Pacific right whales are not expected to be present in the NWTT Study Area. If they are ever present, they are unlikely remain for more than a few days, and therefore are not likely to be present contemporaneous in time or in the vicinity of Navy training and testing activities occurring offshore. As a result, North Pacific right whales are extremely unlikely to be exposed to stressors associated with Navy training and testing activities.

Inland Waters. The rarity of the species and the historical occurrence patterns suggest that right whales would not be present in inland water areas. The occurrence of a North Pacific right whale within the Inland Waters portion of Study Area is considered extralimital.

Western Behm Canal, Alaska. There is no evidence of North Pacific right whale occurrence in waters to the east of the Pacific coast. Given the rarity of the species and the historic occurrence patterns, North Pacific right whales are considered extralimital within the Behm Canal portion of Study Area.

3.4.1.9 Blue Whale (*Balaenoptera musculus*)

3.4.1.9.1 Status and Management

The blue whale is listed as endangered under the ESA, but there is no designated critical habitat for this species. NMFS has determined that more research is still needed to rigorously and specifically define the features that make habitat important to blue whales (National Marine Fisheries Service, 2018c). The world's population of blue whales can be separated into three subspecies, based on geographic location and some morphological differences. In the Study Area, the subspecies *Balaenoptera musculus* is present. As presented in the Pacific SAR, the Eastern North Pacific stock of blue whales includes animals found in the eastern North Pacific from the northern Gulf of Alaska to the eastern tropical Pacific and the stock is considered depleted under the MMPA throughout its range (Carretta et al., 2019c; Carretta et al., 2018b; Carretta et al., 2017c).

3.4.1.9.2 Abundance

Widespread whaling over the last century is believed to have decreased the global blue whale population to approximately 1 percent of its pre-whaling population size (Branch, 2007; Branch et al., 2007; Monnahan, 2013; Monnahan et al., 2014; Rocha et al., 2014; Širović et al., 2004). Off the U.S. West Coast, there has been an increase in the blue whale population size (Barlow, 1994, 1997, 2003), with the highest estimate of abundance in that region in 2014 (Barlow, 2016). A previous suggested decline in the population between 2001 and 2005 (Barlow & Forney, 2007) was likely due to variability in the distribution patterns of blue whales off the coast of North America rather than a true population decline (Barlow, 1997, 2003, 2010; Calambokidis et al., 2009a). Calambokidis et al. (2009a) suggested that when feeding conditions off California are not optimal, blue whales may move to other regions to feed, including waters further north. There has been a northward shift in blue whale distribution within waters off California, Oregon, and Washington (Barlow, 2010, 2016; Carretta et al., 2013a; Širović et al., 2015b). Subsequent mark-recapture estimates reported by Calambokidis et al. (2009a) indicated, "a significant upward trend in abundance of blue whales" at a rate of increase just under 3 percent per year for the U.S. West Coast blue whale population (see also Calambokidis and Barlow (2013)).

The most current information suggests that the Eastern North Pacific population in the Study Area may have recently recovered from commercial whaling, which ended in 1971, despite the impacts of ship strikes, interactions with fishing gear, and increased levels of ambient sound in the Pacific Ocean (Barlow, 1997, 2003, 2016; Calambokidis & Barlow, 2013; Campbell et al., 2015; Carretta et al., 2019c; Carretta et al., 2018a, 2018b; Carretta et al., 2017c; International Whaling Commission, 2016; Monnahan, 2013; Monnahan et al., 2015; Monnahan et al., 2014; Rockwood et al., 2017; Širović et al., 2015b; Valdivia et al., 2019). Findings have suggested that the population of eastern North Pacific blue whales is now near the environment's carrying capacity and that the rate of change of the population size has declined as a result (Carretta et al., 2019c; Carretta et al., 2018a; International Whaling Commission, 2016; Monnahan et al., 2015; Monnahan et al., 2014). Based on NMFS systematic ship surveys from 1991 to 2014, the abundance of blue whales in the area (the combined Oregon/Washington stratum and the Northern California stratum) is estimated at 352 animals (Barlow, 2016).

3.4.1.9.3 Distribution

The Eastern North Pacific Stock of blue whales includes animals found in the eastern north Pacific from the northern Gulf of Alaska to the eastern tropical Pacific (Carretta et al., 2019c; Carretta et al., 2017c). Based on habitat models derived from line-transect survey data collected between 1991 and 2009 off the U.S. West Coast, relatively low densities of blue whales are predicted in the Study Area during the summer and fall (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2016; Forney et al., 2012).

Most blue whale sightings are in nearshore and continental shelf waters; however, blue whales frequently travel through deep oceanic waters during migration and like many mysticetes, spend their summers feeding in productive waters near the higher latitudes and winters in the warmer waters at lower latitudes (Širović et al., 2004). Blue whales in the eastern north Pacific are known to migrate between higher latitude feeding grounds of the Gulf of Alaska and the Aleutian Islands to lower latitudes including Southern California, Baja California, Mexico and the Costa Rica Dome (Calambokidis & Barlow, 2004, 2013; Calambokidis et al., 2009a; Calambokidis et al., 2009b; Mate et al., 2016, 2017; Mate et al., 2018; Mate et al., 2015b; Szesciorka et al., 2020). Researchers have suggested that blue whales in Southern California tend to return to the same feeding areas each year either due to the persistence of foraging hotspots or due to learned behavior (Abrahms et al., 2019; Becker et al., 2018; Calambokidis et al., 2009a; Calambokidis et al., 2009b; Calambokidis et al., 2015; Irvine et al., 2014). Blue whales tagged in Southern California waters along the Pacific coastline have been documented moving south to approximately 7° N latitude (just north of the equator) and north to 50° N latitude off British Columbia, Canada (Mate et al., 2016, 2017; Mate et al., 2018; Mate et al., 2015b). Photographs of blue whales off California have been matched to individuals photographed off the Queen Charlotte Islands in northern British Columbia and the northern Gulf of Alaska (Calambokidis et al., 2009b). Parts of the west coast are known to be blue whale feeding areas for the Eastern North Pacific stock during summer and fall (Bailey et al., 2009; Calambokidis et al., 2009a; Calambokidis et al., 2009b; Mate et al., 2017; Mate et al., 2018; Szesciorka et al., 2020). There have been nine feeding areas identified for blue whales off the U.S. West Coast (Calambokidis et al., 2015), but none of these areas are within the Study Area. In July 2019, two blue whales were observed feeding in shallow water (60 m depth) approximately 17 nautical miles northwest of Grays Harbor, Oregon (Cascadia Research, 2019). Documented sightings of blue whales in the area are rare with the most recent prior sightings of six individuals in feeding 2011; all eight blue whales were identified by photographs as having been documented off Southern California in prior years (Cascadia Research, 2019).

Offshore. In 42 small boat surveys from Grays Harbor out to the 1,000 meter (m) isobath off Quinault conducted over a five-year period in the summer between 2004 and 2009, there was one sighting of a blue whale (Oleson & Hildebrand, 2012). In December 2011, six blue whales were sighted off the Washington coast, which was the highest number of blue whales ever sighted off that coast and only the third confirmed sighting in 50 years (Cascadia Research, 2012b). Model predictions based on tagging data indicated the highest blue whale presence off Washington in June and July with a presence into November (Hazen et al., 2016). Aerial surveys conducted in waters off southern Washington, Oregon, and Northern California covering the approximate nearshore half of the Study Area in the spring, summer, and fall of 2011 and 2012, encountered a total of 16 blue whales only during the fall and only off Oregon (Adams et al., 2014). Acoustic monitoring in waters off the coast of Washington suggested a yearly seasonal pattern of blue whale presence from summer through winter (calls were absent from approximately March through July) (Debich et al., 2014; Kerosky et al., 2013; Oleson & Hildebrand, 2012; Trickey et al., 2015; Wiggins et al., 2017). This seasonality is consistent with the data from satellite-tagged blue whales being in the NWTT Study Area from August through November (summer through fall) (U.S. Department of the Navy, 2018a) and the previously mentioned July 2019 sighting of two blue whale seen foraging off Gray's Harbor, WA (Cascadia Research, 2019). For purposes of the analysis in this Supplemental, blue whales in the Offshore portion of the Study Area are considered to have a seasonal presence.

Between 2014 and 2017, satellite tags were placed on 63 blue whales from the same stock in the waters off the U.S. West Coast, including in the Offshore portion of the NWTT Study Area (Mate et al., 2017; Mate et al., 2018; U.S. Department of the Navy, 2018a). The NWTT Study Area was used by only nine of the 63 tagged blue whales with an average of approximately 23 days spent in the NWTT Study Area; only one of these 63 blue whales ventured as far north as the W-237 Warning Area in waters off Washington (U.S. Department of the Navy, 2018a).

Inland Waters. Blue whales are not expected to occur within the Inland Waters region of the Study Area since it is well inland of the areas normally inhabited by blue whales.

Western Behm Canal, Alaska. Blue whales are not expected to occur within the SEAFAC region of the Study Area since it is well inland of the areas normally inhabited by blue whales.

3.4.1.10 Fin Whale (*Balaenoptera physalus*)

3.4.1.10.1 Status and Management

The fin whale is listed as endangered under the ESA, but there is no designated critical habitat for this species. Fin whale population structure in the Pacific Ocean is not well known. During the 20th century more fin whales were taken by industrialized whaling than any other species (Rocha et al., 2014). In the Study Area, NMFS recognizes two fin whale stocks: (1) the Northeast Pacific stock (Alaska); and (2) the California, Oregon, and Washington stock, and both stocks are considered depleted under the MMPA and (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). Analysis of genetic data suggests that fin whales in the North Pacific interbreed and are a single population (Archer et al., 2019).

3.4.1.10.2 Abundance

There are no reliable current or historical population estimates for the Alaska/Northeast Pacific stock of fin whales (Muto et al., 2017; Muto et al., 2019a). Suggested evidence of an increasing abundance trend for fin whales in Alaskan waters (Zerbini et al., 2006) is consistent with their suggested increase off the U.S. West Coast (Barlow, 2016; Jefferson et al., 2014; Moore & Barlow, 2011; Širović et al., 2015b; Valdivia et al., 2019).

Based on systematic ship survey data collected off the U.S. West Coast from 1991 to 2014, the fin whale is by a large margin the most abundant large whale found in those waters (Barlow, 2016). For the Offshore portion of the Study Area and based on surveys from 1991 to 2014, the abundance for fin whales in the area (the combined Oregon/Washington stratum and the Northern California stratum) is estimated at 2,628 animals (Barlow, 2016). It has been suggested that the increasing number of fin whales seen since 1999 between Vancouver Island and Washington, "… may reflect recovery of the local populations in the North Pacific" (Towers et al., 2018b).

3.4.1.10.3 Distribution

Fin whales prefer temperate and polar waters (Jefferson et al., 2015; Reeves et al., 2002a). This species has been documented from 60° N in Alaska waters, to tropical waters off Hawaii, in Canadian waters both offshore and inland including some fjords, and they have frequently been recorded in waters within the Southern California Bight (Barlow & Forney, 2007; Campbell et al., 2015; Jefferson et al., 2014; Mate et al., 2016, 2017; Mizroch et al., 2009; Širović et al., 2016; Širović et al., 2004; Širović et al., 2015b; Smultea, 2014). As demonstrated by satellite tags and discovery tags[3], fin whales make long-range movements along the entire U.S. West Coast (Falcone et al., 2011; Mate et al., 2016, 2017; Mate et al., 2018; Mate et al., 2015b; Mizroch et al., 2009). Locations of breeding and calving grounds are largely unknown. The species is highly adaptable, following prey, typically off the continental shelf (Azzellino et al., 2008; Panigada et al., 2008). Survey and acoustic data indicate that fin whale distributions shift both seasonally as well as annually (Burnham & Mouy, 2019; Calambokidis et al., 2015; Douglas et al., 2014; Jefferson et al., 2014). When seasonally present in northern British Columbia waters of Hecate Strait, Queen Charlotte Sound, and Greater Caamaño Sound, satellite tag data and photographic identifications indicated little movement of fin whales between the inshore areas and the offshore regions of the Canadian Pacific (Nichol et al., 2018). Acoustic data gathered off Clayquot Sound,

[3] As a means of data collection starting in the 1930s, discovery tags having a serial number and return address were shot into the blubber of the whale by scientists and if that whale was later harvested by the whaling industry and the tag "discovered" during flensing, it could be sent back to the researchers providing data on the movement of individual whales.

British Columbia, indicated fin whales calls were primarily heard in the shelf-break zones (Burnham & Mouy, 2019).

Offshore. In 42 small boat surveys from Grays Harbor out to the 1,000 m isobath off Quinault conducted over a five-year period in the summer between 2004 and 2009, there was one sighting of a group of three fin whales (Oleson & Hildebrand, 2012). During aerial surveys conducted within the 2,000 m isobath off southern Washington, Oregon, and Northern California in the spring, summer, and fall of 2011 and 2012, there were six sightings of 13 fin whales during winter and summer 2012 only in offshore waters over the continental slope (Adams et al., 2014). Between 2014 and 2017, 32 fin whales were instrumented with satellite tags in the waters off the U.S. West Coast (Mate et al., 2017; U.S. Department of the Navy, 2018a); all these whales are from the same stock as present in the NWTT Study Area. Only four of the 32 fin whales ventured into the NWTT Study Area. One of the four traveled only as far north as the California/Oregon border, and another, occurring in waters off Washington, only passed through the NWTT Study Area briefly on its way farther north into Canadian waters. Across the tag data sample years, fin whale use of the NWTT Study Area occurred primarily in late summer and fall (Mate et al., 2017; U.S. Department of the Navy, 2018a). Consistent with sightings from systematic ship surveys out to 300 NM off the U.S. West Coast and satellite tag data, habitat-based density models built with these data indicate that fin whales are more likely to be present seaward of the continental shelf in the offshore portion of the Study Area (Barlow, 2016; Becker et al., 2020; Becker et al., 2016).

Acoustic monitoring has indicated a yearly seasonal pattern of fin whale calls in the Study Area off Washington and Canada with the absence of calls from approximately May through July (Debich et al., 2014; Kerosky et al., 2013; Oleson & Hildebrand, 2012; Soule & Wilcock, 2013; Trickey et al., 2015; Wiggins et al., 2017); fin whale calls were dominate in December and February off Clayquot Sound, British Columbia (Burnham & Mouy, 2019), located north of the NWTT Offshore area. Consistent with those findings and the satellite tag data, a seafloor seismic network at the Strait of Juan de Fuca was used to study fin whale calls and suggested northward movement of transiting fin whale groups from August to October and a southward movement from November to April (Soule & Wilcock, 2013). For purposes of the analysis in this Supplemental, fin whales in the Offshore portion of the Study Area are considered to have a regular presence.

Inland Waters. Fin whales are not expected to occur within the Inland Waters region of the Study Area since fin whales have seldom been documented in the area. Lone fin whales were sighted in the Strait of Juan de Fuca between September and December 2015, in July 2016, and again in October 2017; these were three of only 10 total fin whale sightings in the Salish Sea since 1930 (Cogan, 2015; Daugherty, 2016; Nichol et al., 2018; Towers et al., 2018b).

Western Behm Canal, Alaska. Surveys in Southeast Alaska between 1991 and 2007 encountered a total of seven fin whales, only in the summer, and only off the southern tip of Prince of Wales Island and the southern end of Clarence Strait in proximity to the open ocean (Dahlheim et al., 2009). The limited number of sightings from those surveys and a documented presence limited to a proximity to the open ocean suggests fin whale presence in Behm Canal would be rare. Based on the sighting of fin whales in Clarence Strait and Dixon Entrance (Dahlheim et al., 2009; Nichol et al., 2018) and for purposes of the present analysis, the Navy assumes fin whales may be present in small numbers within the SEAFAC region of the Study Area.

3.4.1.11 Sei Whale (*Balaenoptera borealis*)

3.4.1.11.1 Status and Management

The sei whale is listed as an endangered under the ESA, but there is no designated critical habitat for this species (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017c). A single Eastern North Pacific stock is recognized in the U.S. EEZ and that stock is considered depleted under the MMPA (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017c).

3.4.1.11.2 Abundance

There is no estimate of an abundance for sei whales in the Behm Canal given there is no indication that the species is present in the area (Dahlheim et al., 2009); the species is not included in the Alaska SAR (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a).

There has been an increase in sei whales off the Washington and Oregon coast in recent years, with more groups of sei whales sighted in 2014 than in all previous NMFS surveys combined (Barlow, 2016). This increase in the NWTT Study Area is consistent with a significant population trend increase for the Eastern North Pacific stock overall (Valdivia et al., 2019). Line transect surveys in 2010 and 2012 in the central and eastern North Pacific, Gulf of Alaska, and off Southeast Alaskan and British Columbia, Canada to 40° north latitude indicate that the abundance of sei whales in the North Pacific is 34,718 individuals (Hakamada et al., 2017).

For the Offshore portion of the Study Area and based on surveys from 1991 to 2014, the abundance of sei whales in the area (California, Oregon, and Washington waters) is estimated at 519 animals (Barlow, 2016; Carretta et al., 2018a).

3.4.1.11.3 Distribution

Sei whales have a worldwide distribution and are found primarily in cold temperate to subpolar latitudes across the North Pacific where there is steep bathymetric relief, such as the continental shelf break, canyons, or basins between banks and ledges (Best & Lockyer, 2002; Burnham & Mouy, 2019; Gregr & Trites, 2001; Horwood, 1987; Horwood, 2009). Sei whales are migratory, spending the summer months feeding in the subpolar higher latitudes and returning to the lower latitudes to calve in the winter (Fulling et al., 2011; Horwood, 1987; Horwood, 2009; Olsen et al., 2009; Rone et al., 2017; Smultea, 2014; Smultea et al., 2010). In the winter in the Pacific, sei whales have been detected as far south as the Mariana Islands, Hawaii, and Southern California (Fulling et al., 2011; Smultea, 2014; Smultea et al., 2010). Analysis of sei whale genetic samples from around the Pacific suggests a single stock present in the Pacific ((Baker et al., 2006; Huijser et al., 2018).

Offshore. Sei whales are expected to be present in the Offshore potion of the Study Area (Barlow, 2016; Williams & Thomas, 2007). Acoustic monitoring in March and April of 2016 off Clayquot Sound, British Columbia to the north of the Offshore portion of the NWTT Study Area, documented the presence of sei whale downsweep calls at all three recording stations (Burnham & Mouy, 2019).

Inland Waters. There are no records of sei whales being sighted or otherwise present in the Inland Waters potion of the Study Area (Gregr et al., 2006; U.S. Department of the Navy, 2017h).

Western Behm Canal, Alaska. There are no data to indicate that sei whales ever venture from the Pacific into areas like Behm Canal (see Dahlheim et al. (2009)) and the species is not included in the Alaska SAR (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a).

Odontocetes

3.4.1.12 Minke Whale (*Balaenoptera acutorostrata*)

3.4.1.12.1 Status and Management

Minke whales are not considered a threatened or endangered species under the ESA, and neither stock of minke whales in the Study Area is considered depleted under the MMPA. Minke whales in the Behm Canal portion of the Study Area belong to the Alaska stock (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a), and those in the Offshore and Inland Waters portion belong to the California, Oregon, Washington stock (Carretta et al., 2019c; Carretta et al., 2017c).

3.4.1.12.2 Abundance

There is no estimate of minke whale abundance in the Behm Canal given the area has not been surveyed (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). For the Offshore and Inland Waters portion of the Study Area and based on surveys from 1996 to 2014, the abundance for minke whales in the area (the combined Oregon/Washington stratum and the Northern California stratum; CV >1.0) is estimated at 506 animals (Barlow, 2016).

3.4.1.12.3 Distribution

Minke whales have a predominant nearshore distribution along the coast of North America (Hamilton et al., 2009). In the eastern North Pacific Ocean including the Study Area, year round observations over multiple years have only visually detected minke whales between March and November (Adams et al., 2014; Cogan, 2015; Debich et al., 2014; Oleson et al., 2009; Smultea et al., 2017; Towers et al., 2013). This spring to fall occurrence includes small numbers of minke whales that feed over or near shallow banks, such as are present in the Cormorant Channel off northeastern Vancouver Island (Nikolich & Towers, in press). This occurrence pattern along with other ecological evidence indicates seasonal migrations to warmer waters during the winter season (Towers et al., 2013). Because there have been sightings of individual minke whales in the Inland Waters portion of the Study Area during winter (December and January) in years past (Everitt et al., 1980), it is conservatively assumed that minke whale are present in the Study Area year round.

In the Behm Canal and Offshore portions of the Study Area, most minke whales are believed to be in constant movement while foraging, given the findings from a seven-year study of the population present at Johnstone Strait (north of Vancouver Island) (Dorsey et al., 1990). In contrast, minke whales around the San Juan Islands in the inland waters of Washington appear to frequent specific home ranges where animals mill about and feed over periods of hours (Dorsey, 1983; Dorsey et al., 1990; Muto et al., 2017; Towers et al., 2013). Photo-identification of individual minke whales has indicated intra-annual movements in excess of approximately 400 km between feeding areas in the coastal waters of northern British Columbia to the inland waters of Washington (Towers et al., 2013).

Offshore. Minke whales are expected to seasonally be present, but minke whale vocalizations have only been detected in passive acoustic monitoring twice in the Offshore portion of the Study Area; in November 2012 and April 2013 (Debich et al., 2014). Minke whale vocalizations have been absent from all other monitoring periods (Kerosky et al., 2013; Širović et al., 2012a; Trickey et al., 2015). Minke whales are relatively infrequently visually detected in the region (Barlow, 2016; Oleson et al., 2009; Williams & Thomas, 2007). During NMFS systematic shipboard surveys of the region, minke whales have been encountered offshore Washington as lone individuals totaling six in 1996, two in 2001, and two in 2014 (Barlow, 2016). During aerial surveys in 2011 and 2012 there were six sightings in summer and fall over the Oregon shelf waters portion of the Study Area (Adams et al., 2014). For purposes of the analysis in this Supplemental, minke whales offshore are considered to have a regular presence.

Inland Waters. Based on the record of opportunistic marine mammal sightings in the Inland Waters portion of the Study Area (Everitt et al., 1980; U.S. Department of the Navy, 2017h), minke whales have been generally observed as lone individuals, with the exception of larger groups occasionally observed in the Strait of Juan de Fuca and in the vicinity of the San Juan Islands (Cogan, 2015; Dorsey et al., 1990; Smultea et al., 2017; Towers et al., 2013). For purposes of the analysis in this Supplemental, minke whales in the Inland Waters portion of the Study Area are considered to have a regular presence.

Western Behm Canal, Alaska. Minke whales were observed infrequently during the spring through fall 1991–2007 surveys of the inland waters of southeast Alaska (Dahlheim et al., 2009). Although surveys have not been conducted in the winter months in southeast Alaska, it is possible that minke whales may be present in the winter, and that is assumed to be the case for this analysis. For purposes of the analysis in this Supplemental, minke whales in the Behm Canal portion of the Study Area are considered to have a regular presence.

3.4.1.13 Humpback Whale (*Megaptera novaeangliae*)

3.4.1.13.1 Status and Management

Humpback whales expected to be present in the Study Area are from three DPSs, given they represent populations that are both discrete from other conspecific populations and significant to the species of humpback whales to which they belong (Carretta et al., 2019c; Carretta et al., 2018b; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a; National Marine Fisheries Service, 2016a; Titova et al., 2017). These DPSs in the Study Area are based on animals identified from breeding areas in Hawaii, Mexico, and Central America (Bettridge et al., 2015; Carretta et al., 2019c; Carretta et al., 2018b; Carretta et al., 2017c; Darling et al., 1996; Muto et al., 2017; Muto et al., 2019a; National Marine Fisheries Service, 2016a; Titova et al., 2017; Wade et al., 2016). The portion of the humpback whale population in the Study Area that is from the Hawaii DPS was delisted under the ESA given that this population segment is believed to have fully recovered and had an abundance greater than the pre-whaling estimate (Barlow et al., 2011; Bettridge et al., 2015; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a; National Marine Fisheries Service, 2016a; Wade et al., 2016). Humpback whales in Study Area from the Mexico DPS are listed as threatened, and those from the Central America DPS are listed as endangered under the ESA (Carretta et al., 2019c; National Marine Fisheries Service, 2016a).

There is no designated critical habitat for these ESA-listed humpback whales in the North Pacific (Carretta et al., 2019c; Carretta et al., 2018b; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a), but a proposal for designation of critical habitat was presented by NMFS for comment on October 9, 2019 in the Federal Register (84 FR 54378). The proposed critical habitat would be for the humpback whales within the U.S. EEZ including the endangered Western North Pacific DPS and Central America DPS, and the threatened Mexico DPS pursuant to section 4 of the ESA. NMFS does not address or otherwise recognize any areas outside the U.S. EEZ as critical habitat due to the regulations implementing the ESA. In the proposal, NMFS considered 19 Regions/Units of habitat as critical habitat for the listed humpback whale DPSs in U.S. waters. These 19 areas include almost all coastal waters off California, Oregon, Washington, and Alaska in the Pacific. The NMFS designated, named, and numbered habitat “regions/units” (the names in the NMFS-provided information are not yet consistent in this regard) are shown on Figure 3.4-2 and Figure 3.4-3. As shown, there is overlap between the NWTT Study Area and portions of the habitat designated Regions/Units 10, 11, 12, 13, 14, and 15.

Region/Unit 10; Southeastern Alaska – This proposed area extends from the Pacific Coast at 139°24' west longitude offshore to the 2,000 m isobath and to the southeast including all inland waters to the U.S. border with Canada. This area of proposed critical habitat overall covers 22,152 square nautical miles (NM^2) of marine habitat including the inland waters of Western Behm Canal where the Navy's activities at SEAFAC is located (Figure 3.4-2). NMFS rated Region/Unit 10 overall as having a ''medium'' conservation value given it includes some of the designated humpback whale feeding BIAs (Ferguson et al. 2015). The Navy's activities at SEAFAC occur in a relatively small area of inland waters comprising only 0.22 percent of Region/Unit 10 overall. Furthermore, SEAFAC is entirely outside any designated humpback whale feeding BIA (Ferguson et al. 2015). In the analysis considering proposed critical habitat (84 FR 54378), NMFS indicated that the impact to the military readiness activities at SEAFAC, the "extremely small relative size" of the SEAFAC area (48 NM^2), the medium conservation rating of the habitat, and fact that other federal activities are unlikely to occur in the SEAFAC area, meant that the benefits of excluding SEAFAC due to national security impacts outweighed the benefits of designating that area as critical habitat for the Mexico DPS humpback whales that seasonally inhabit the location. Therefore, NMFS proposed excluding the SEAFAC area from the designation of critical habitat for the Mexico DPS of humpback whales, and adjusted the boundaries of Region/Unit 10 accordingly.

Region/Unit 11; Coastal Washington – As shown on Figure 3.4-3, this area begins at the boundary between the U.S. and Canadian EEZ and extends southward to 46° 50' north latitude, which is located just north of Willapa Bay, WA. The region/unit also includes inland waters within the U.S. portion of the Strait of Juan de Fuca extending eastward to Angeles Point (123° 33' west longitude; a location approximately 5 miles to the west of Port Angeles). Offshore, the 50-m isobath forms the shoreward boundary with the unit, which extends offshore to the 1,200 m isobath. The northern part of this region/unit of proposed critical habitat encompasses the designated Northern Washington humpback whale feeding BIA (Calambokidis et al., 2015). It should be noted that the humpback whale BIA and the proposed critical habitat do not include the portion of the same feeding area extending beyond the U.S. EEZ border with Canada to the waters off southern British Columbia at Swiftsure Bank and beyond (Mate et al., 2019; National Marine Fisheries Service, 2019e; Nichol et al., 2017; Santora et al., 2017). In total, Region/Unit 11 covers 3,441 NM^2 of marine habitat off Washington and overlaps with the Offshore and the Inland Waters portions of the NWTT Study Area. This Region/Unit was rated as having a high conservation value for the Central America DPS humpback whales and a very high value for the Mexico DPS. The Navy informed NMFS that ongoing and future testing activities in the Offshore area at the Quinault Range, which overlaps with approximately 33 percent of Region/Unit 11, could be impacted by the designation of critical habitat. The Navy therefore requested that the Quinault Range area, plus an additional 10-km buffer, be excluded to avoid impacts to those military readiness activities. NMFS determined that an exclusion of the Quinault Range and buffer area would not remove much of the comparatively high value locations within Region/Unit 11, that the benefits of excluding the Navy range and buffer due to national security impacts outweighed the benefits of designating this portion of Region/Unit 11 as critical habitat, and therefore proposed to exclude the Quinault Range and buffer area from critical habitat designation.

Region/Unit 12; Columbia River Area – As shown on Figure 3.4-3, this area extends southward from 46° 50' north latitude to 45° 10' north latitude and offshore starting from the 50 m isobath out to the

1,200 m isobath. This region/unit covers 3,636 NM^2 of marine habitat and partially overlaps the nearshore margin of the Offshore portion of the NWTT Study Area.

Region/Unit 13; Coastal Oregon – As shown on Figure 3.4-3, this area extends southward from 45° 10' north latitude to 42° 10' north latitude (just south of Pacific City, Oregon), and offshore starting from the 50 m isobath out to the 1,200 m isobath. This area of proposed critical habitat includes the Stonewall and Heceta Bay humpback whale feeding BIA described by Calambokidis et al. (2015), which is located off Newport, Oregon. Region/Unit 13 covers 5,750 NM^2 of marine habitat and partially overlaps the nearshore margin of the Offshore portion of the NWTT Study Area.

Region/Unit 14; Southern Oregon/Northern California – As shown on Figure 3.4-3, this area extends southward from 42° 10' north latitude to 40° 20' north latitude and offshore starting from the 50 m isobath out to the 2,000 m isobath. This southern boundary for this region/unit of proposed critical habitat is aligned with the Gorda Escarpment that is a bathymetric feature located off the coast approximately 16 NM south of Ferndale, California. This area of proposed critical habitat includes the Point St. George humpback whale feeding BIA located offshore of the Oregon/California border (Calambokidis et al., 2015). Region/Unit 14 covers 3,412 NM^2 of marine habitat and partially overlaps the nearshore margin of the Offshore portion of the NWTT Study Area.

Region/Unit 15; California North Coast Area – As shown on Figure 3.4-3, only a small portion of this proposed critical habitat overlaps with the nearshore margin of the Offshore portion of the NWTT Study Area. Region/Unit 15 extends from approximately 40° 20' north latitude and extends southward to 38° 40' north latitude and offshore starting from the 50 m isobath out to the 3,000 m isobath. Region/Unit 15 covers 4,898 NM^2 of marine habitat.

The Navy has incorporated analysis of proposed Critical Habitat into the analysis presented in this Supplemental in Section 3.4.2 (Environmental Consequences) and is conferencing with NMFS under ESA with regards to the proposed humpback whale critical habitat.

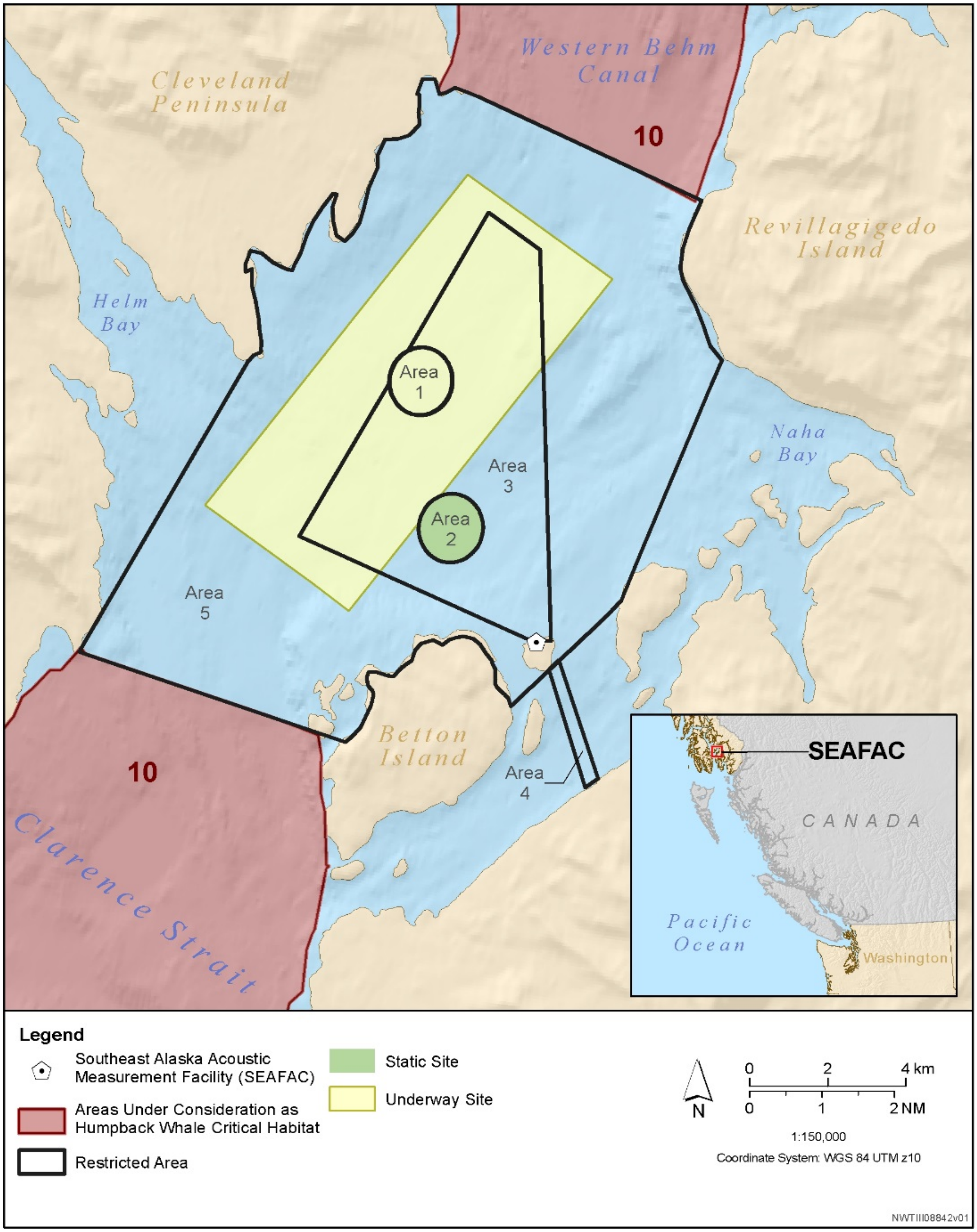


Figure 3.4-2: The NMFS Region/Unit 10 Portion of Proposed Humpback Whale Critical Habitat in and Around Western Behm Canal and the SEAFAC Range

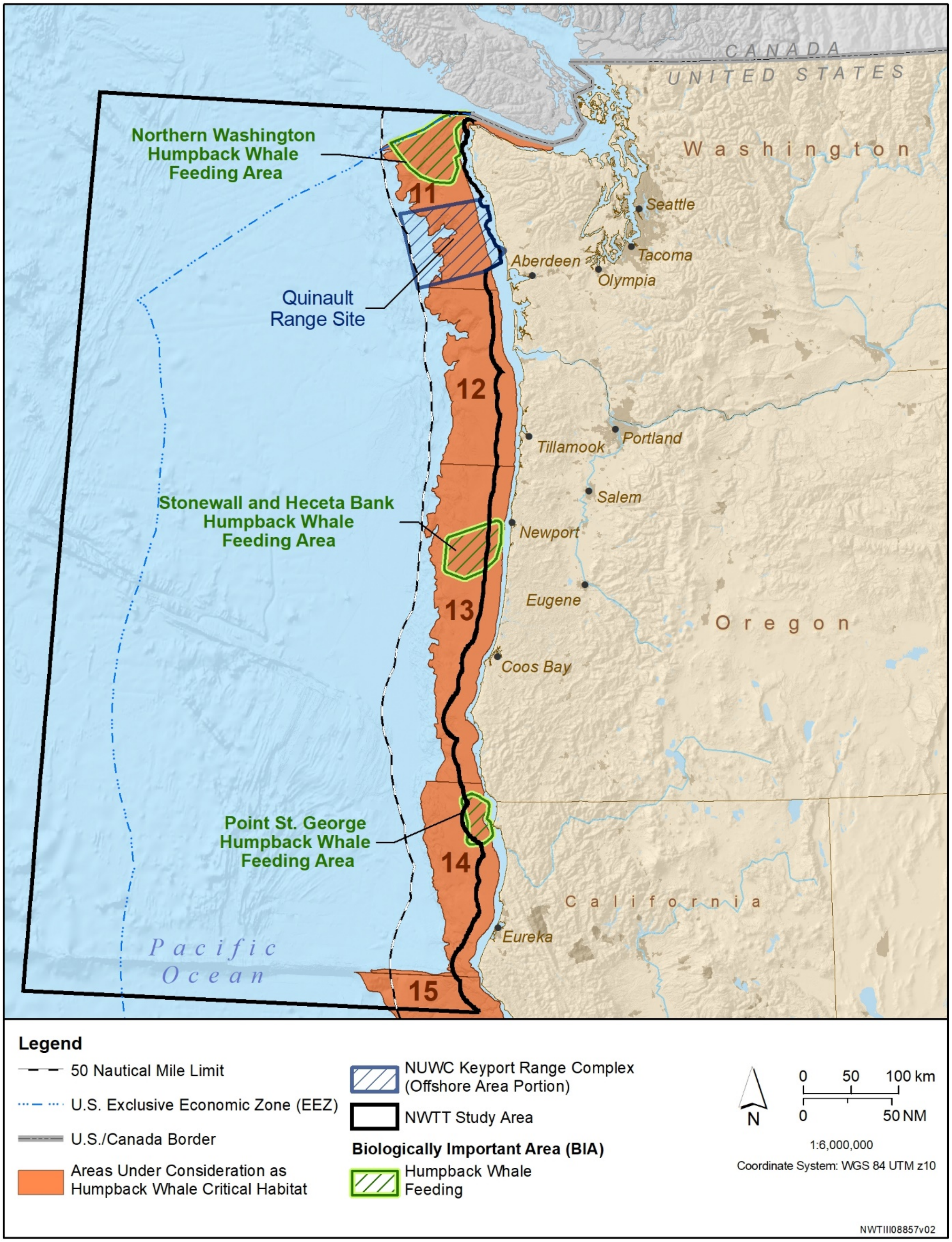


Figure 3.4-3: The NMFS Proposed and Numbered Humpback Whale Critical Habitat Regions/Units in Waters of Washington, Oregon, and California Overlapping the NWTT Study Area

In the North Pacific Ocean and under the MMPA, the stock structure of humpback whales is defined by NMFS based on the stock's fidelity to feeding grounds (Bettridge et al., 2015; Carretta et al., 2019c; Carretta et al., 2018b; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a; National Marine Fisheries Service, 2016a). Additionally, there is evidence suggesting the mixing of the humpback whale populations throughout the North Pacific (Darling et al., 2019; Darling et al., 1996; Hill et al., 2018; Palacios et al., 2020a; Titova et al., 2017). As a result, the stock designations are inconsistent with the DPS designations[4], and although NMFS is evaluating the stock structure of humpback whales under the MMPA, no changes to current stock structure have been provided to date (Carretta et al., 2019c; Carretta et al., 2018b; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). The majority of the humpback whales present in the Alaska and Washington portions of the Study Area (that are generally feeding), spend the winter and spring in Hawaii breeding, calving, or nursing (National Marine Fisheries Service, 2016e, 2016l). NMFS has designated those animals from Hawaii that are present in Alaska, British Columbia, and Washington in the summer and early fall as being part of the Central North Pacific stock given they migrate to those areas in the Central North Pacific to feed (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). The Central North Pacific stock is not considered depleted under the MMPA. The Central North Pacific stock includes animals that winter in many locations other than Hawaii including, for example, humpback whales from Mexico (Calambokidis et al., 2008; Muto et al., 2018b; Muto et al., 2019a; National Marine Fisheries Service, 2016e; Wade et al., 2016).

The remainder of humpback whales expected to be present in the Study Area are designated by NMFS as being from the California, Oregon, Washington stock. This stock is defined by NMFS as including only those animals that migrate northward from their winter breeding grounds in Mexico and Central America to feeding areas along the U.S. West Coast off the United States, including the waters of the Study Area (Bettridge et al., 2015; Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017c;

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[4] Between 1990 and 1993 in the Okinawa/Osagawara breeding area of the Western North Pacific DPS, a photographically identified female humpback whale was observed on four occasions (once with a calf) and in 1991, this same individual was observed off La Perouse Bank, in Canadian waters (Darling et al., 1996). La Perouse Bank, is centered approximately 20 NM north of the NWTT Study Area. In 1991, only 24 individual humpback whales had been photo-identified during small boat surveys in waters off Northern Washington/British Columbia (Calambokidis et al., 2004) and a total of 177 had been identified in Japan waters (Darling et al., 1996). Given the small sample sizes of the photo-identification data in 1991 for the Western North Pacific DPS in the two areas involved, this one detection may represent a much more prevalent occurrence of Western North Pacific DPS whales in the vicinity of the NWTT Study Area. In addition data provided by Titova et al. (2017), subsequent to the NMFS reviews cited above, found photo-ID matches between humpbacks in Russian waters with 35 animals in Hawaiian breeding grounds and 11 animals in Mexican breeding grounds. These Russian waters/Western North Pacific stock whales are designated in the Alaska stock assessment report as representing the Okinawa/Osagawara/Philippines or Western North Pacific DPS (Muto et al., 2018a; Muto et al., 2018b). Thus, this new data along with photo-identification data having matches between what are supposed to be separate breeding areas and feeding areas results in further inconsistencies, with the stock structure of Central North Pacific stock whales being the Hawaii DPS, and the California, Oregon, Washington stock being mostly comprised by the Mexico DPS (see Carretta et al. (2019c); Palacios et al. (2020a)). The Navy's analysis presumes that, due to the Western North Pacific stock/DPS being few in number and the NWTT Study Area outside their main feeding area in the western North Pacific, Western North Pacific DPS/stock humpback whales are not likely to be present in the NWTT Study Area during or in proximity to any of the proposed training or testing activities. Therefore, Western North Pacific DPS/stock humpback whales would not be affected by the Proposed Action.

National Marine Fisheries Service, 2016a, 2016e, 2016l). The California, Oregon, Washington stock is considered depleted under the MMPA.

3.4.1.13.2 Abundance

Although there is no site-specific data for Behm Canal, anecdotal reports of increasing local observations of humpback whales within Behm Canal is consistent with the increasing Central North Pacific stock observed in Alaska waters (Barlow et al., 2011; Bettridge et al., 2015; Muto et al., 2019b; National Marine Fisheries Service, 2016e; National Oceanic and Atmospheric Administration, 2019d; Wade et al., 2016). This is also consistent with the reported increase in the California, Oregon, Washington stock (Carretta et al., 2019c; Carretta et al., 2018b) that are also seasonally present in Southeast Alaska. Based on those publications, it is reasonable to assume that the abundance of humpback whales in Southeast Alaska is increasing (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a; Muto et al., 2019b), although there is also information to suggest the previous rate of increase in the Pacific feeding areas may be slowing based on data from Glacier Bay Alaska and northern British Columbia (Neilson & Gabriele, 2019; Wray & Keen, 2019).

In inland waters of Washington including the Strait of Juan de Fuca, Puget Sound, and other parts of the Salish Sea, scientists have noted a trend of increased humpback whale abundance (Calambokidis et al., 2017a; Cascadia Research, 2017d; Cogan, 2015; Palacios et al., 2020a). This is consistent with the pattern of increasing humpback whale abundance in the Pacific as suggested by data from previous years (Barlow et al., 2011; Calambokidis & Barlow, 2013; Calambokidis et al., 2017a; Carretta et al., 2019c) and with the highest-yet abundance for the California, Oregon, Washington stock of humpback whale as observed in the NMFS 2014 survey of the U.S. West Coast (Barlow, 2016). For the Offshore and Inland Waters portion of the Study Area and based on surveys from 1991 to 2014, the abundance for humpback whales in the area (the combined Oregon/Washington stratum and the Northern California stratum) is estimated at 834 animals (Barlow, 2016).

3.4.1.13.3 Distribution

Humpback whales are distributed worldwide in all major oceans and most seas. They typically are found during the summer on high-latitude feeding grounds, including inland waters and fjords, and during the winter in the tropics and subtropics around islands, over shallow banks, and along continental coasts, where calving occurs (Barlow et al., 2011; Bettridge et al., 2015; Calambokidis et al., 2017a; Calambokidis et al., 2010; Keen et al., 2018; Wade et al., 2016; Wray & Keen, 2019). Based on sightings and habitat models derived from line-transect survey data collected between 1991 and 2014 off the U.S. West Coast, humpback whales are distributed primarily in nearshore waters during the summer and fall, with a significantly greater proportion of the population found farther offshore during the winter (Barlow et al., 2009; Becker et al., 2020; Becker et al., 2010; Becker et al., 2016; Becker et al., 2017; Campbell et al., 2015; Forney & Barlow, 1998; Forney et al., 2012). Visual surveys and acoustic monitoring studies have detected humpbacks along the Washington coast year-round, with peak occurrence during the summer and fall (Cogan, 2015; Debich et al., 2014; Emmons et al., 2017; Emmons et al., 2019a; Oleson et al., 2009; Širović et al., 2012a; Trickey et al., 2015).

There have been three locations identified as biologically important humpback whale feeding areas located in or near the offshore portion of the Study Area (Calambokidis et al., 2015). It is important to note there are also other additional important humpback whale feeding areas used by the same stocks of humpback whales, which are outside of the NWTT Study Area (Ashe et al., 2013; Best et al., 2015; Calambokidis et al., 2015; Dalla-Rosa et al., 2012; Ferguson et al., 2015a; Keen et al., 2018; Mate et al., 2019; Mate et al., 2020; National Marine Fisheries Service, 2019e; Nichol et al., 2017; Palacios et al., 2020b; Santora et al., 2017). As shown in the 2015 NWTT Final EIS/OEIS on Figure 3.4-2 (U.S. Department of the Navy, 2015a), there are three humpback whale feeding areas in U.S. waters in and around the offshore portion of the Study Area. These areas and their seasonal use periods are (1) Point St. George (feeding July to November), (2) Stonewall and Heceta Bank (feeding May–November), and (3) Northern Washington (feeding May–November) (Calambokidis et al., 2015). Each of these areas is primarily used annually during the approximate six-to-seven-month period when humpback whale feeding occurs at those locations. Specifically for the Northern Washington feeding area, shipboard surveys in July 2005 that included both U.S. and Canadian waters found that humpback whale sightings were concentrated around the edge of what appears to be the semi-permanent eddy associated with the outflow from the Strait of Juan de Fuca (Dalla-Rosa et al., 2012; Santora et al., 2017). The majority of this semi-permanent eddy and associated feeding area is contiguous with the designated biologically important feeding area, but the northern boundary of the designated feeding area has been drawn as the line between the U.S. and Canadian EEZs. The designated biologically important area was bounded to the north by Canadian waters because the identification of biologically important areas was restricted to only in U.S. waters (Calambokidis et al., 2015; Ferguson et al., 2015b). In the designation of biologically important areas (BIAs) to only locations within U.S. waters, it was made clear that, "…the absence of BIA designations outside U.S. waters should not be interpreted as an absence of BIAs in those waters" (Ferguson et al., 2015b). In addition to feeding areas in Canada, including the inland fjords and Johnstone Strait (Ashe et al., 2013; Best et al., 2015; Ford et al., 2010; Keen et al., 2018), there are consistent concentrated feeding areas in Canadian waters offshore of British Columbia, including off Haida Gwaii, on the continental shelf break between Cape St. James and Cape Scott at Vancouver Island, at the mouth of the Strait of Juan de Fuca, and between Southeast Alaska and Canada at Dixon Entrance (Best et al., 2015; Dalla-Rosa et al., 2012; Ford et al., 2010; Santora et al., 2017; Wray & Keen, 2019).

Analyses of Navy training and testing activities in relation to these biologically important feeding areas for humpback whales were previously completed in the 2015 NWTT Final EIS/OEIS (U.S. Department of the Navy, 2015a), evaluated by NMFS in the issuance of the current Letter of Authorization pursuant to the MMPA (National Oceanic and Atmospheric Administration, 2015b), and reviewed by NMFS pursuant to ESA for listed species in the Study Area (National Marine Fisheries Service, 2014). There is no new applicable science that necessitates any changes in those previous analyses. Documentation that environmental variability can impact the local abundance, feeding, and migratory behaviors (see for example, Ryan et al. (2019) and Gabriele et al. (2017)), suggests that a dynamic management approach is more effective than consideration of static bounded areas such as BIAs. For additional details regarding the Navy's analyses, see Section 3.4.2.1 (Acoustic Stressors) and Appendix K (Geographic Mitigation Assessment) in this Supplemental as well as the 2015 NWTT Final EIS/OEIS (U.S. Department of the Navy, 2015a).

Offshore. Humpback whales are expected to be present in the Offshore portion of the Study Area year round. The pattern of increasing humpback whale abundance indicated by previous investigations (Barlow et al., 2011; Calambokidis & Barlow, 2004, 2013; Calambokidis et al., 2017a) appears consistent with the highest-yet abundances of these species in 2014 (Barlow, 2016). Acoustic monitoring over a number of years has demonstrated an overwintering presence of humpback whales and suggests that some portion of the humpback whale population off Washington remain in temperate waters during the winter (Debich et al., 2014; Emmons et al., 2017; Kerosky et al., 2013; Oleson & Hildebrand, 2012; Širović et al., 2012a; Trickey et al., 2015). Satellite tag location data from humpback whales within the Offshore portion of the NWTT Study Area indicate a preference for shallow waters (>200 m depth) consistent with generally known patterns of humpback whale distribution along the Pacific coast (Barlow et al., 2011; Becker et al., 2017; Campbell et al., 2015; Ford et al., 2010; Forney & Barlow, 1998; Mate et al., 2019; Mate et al., 2017; U.S. Department of the Navy, 2018a). Five humpback whales were tracked in the NWTT Study Area using satellite tags in 2016 (Mate et al., 2017; U.S. Department of the Navy, 2018a). One humpback whale tagged in the waters north of Monterey California was tracked for 85 days moving more than 900 km to waters offshore of Pacific City, Oregon (U.S. Department of the Navy, 2018a). While heading north, this individual took an offshore route as far as 200 km from shore and then returned south along a more inshore route. This whale and two others (one tagged off of Newport, Oregon, and the other off Astoria, Oregon) spent portions of time in nearshore shallow waters (less than 200 m in depth) or in Canadian waters, during which they were outside of the NWTT Study Area and the locations where Navy training and testing activities occur (Mate et al., 2017; U.S. Department of the Navy, 2018a). The remaining two of the five tracked humpback whales were tagged near Cape Blanco, in southern Oregon, and spent most of their time beyond the NWTT Study Area in continental shelf waters off Trinidad Head and Eureka, California (U.S. Department of the Navy, 2017c). In August 2018, a total of 20 humpback whales were tagged near Swiftsure Bank and in waters between Tatoosh Island and Neah Bay, Washington; in early September, an additional five humpback whales were tagged off Newport Oregon (Mate et al., 2019). The locations for these tagged whales ranged from waters north of Vancouver Island, Canada and as far south as Magdalena Bay, Baja California, Mexico. Consistent with the semi-permanent eddy associated with the outflow from the Strait of Juan de Fuca (Dalla-Rosa et al., 2012; Santora et al., 2017) and the recognized presence of a feeding area spanning U.S. and Canadian waters (Calambokidis et al., 2015; Ford et al., 2010; Nichol et al., 2017), the densest area of subsequent locations for the whales off Washington remained their original tag deployment location over Swiftsure Bank in Canadian waters approximately 25 km northwest of Cape Flattery (Mate et al., 2019). The locations for the five humpback whales tagged off of Newport were concentrated north of Stonewall Bank and south of Heceta Bank (Mate et al., 2019), which together are a designated biologically important feeding area for the species (Calambokidis et al., 2015). The results from this tagging work demonstrate variability between years in use of the biologically important feeding areas with multiple satellite tagged humpback whales off Washington and Oregon having high use areas outside the designated feeding area boundaries (Mate et al., 2015b; Palacios et al., 2019; Palacios et al., 2020a; Palacios et al., 2020b).

Inland Waters. Data indicate that an increasing number of humpback whales are seasonally present in the Inland Waters portion of the Study Area and that this trend escalated in 2014 (Calambokidis et al., 2017a; Cascadia Research, 2017d; Palacios et al., 2020a). Based on opportunistic and informal sighting reports in 2015, it was estimated that there were as many as 15–25 whales present in the Inland Waters portion of the Study Area during any given day (Cogan, 2015).

Western Behm Canal, Alaska. Humpback whales are assumed to be present in Behm Canal (U.S. Department of the Navy, 1991). In summer, relatively high densities of humpback whales occur throughout much of Southeast Alaska (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a) and Northern British Columbia (Ashe et al., 2013; Best et al., 2015; Ford et al., 2010; Keen et al., 2018), and they were observed frequently during spring through fall in a series of surveys from 1991 to 2007 in Southeast Alaska (Dahlheim et al., 2009). Although surveys have not been conducted in the winter months in Southeast Alaska, humpback whales have been seen during the winter in Lynn Canal, indicating that some of these animals do not migrate south and remain in Southeast Alaskan waters to feed on herring (Moran et al., 2009). For purposes of the acoustic effects modeling, Navy assumes humpback whales may be present in Behm Canal in all seasons.

3.4.1.14 Gray Whale (*Eschrichtius robustus*)

3.4.1.14.1 Status and Management

There are two north Pacific populations of gray whales: the Eastern subpopulation and the Western subpopulation designated in the Pacific SAR (Carretta et al., 2019c; Carretta et al., 2018b; Carretta et al., 2017c; Weller et al., 2013). Both populations could be present in the Study Area during their northward and southward migration (Calambokidis et al., 2017b; Calambokidis et al., 2015; Mate et al., 2015a; Sumich & Show, 2011; Weller et al., 2013).

The Eastern North Pacific subpopulation (also known as the California-Chukchi population) has recovered from whaling exploitation and was delisted under the ESA in 1994 (Swartz et al., 2006). This population has been designated the Eastern North Pacific stock and is not considered depleted (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017c).

The Western subpopulation, which was previously also known as the western north Pacific or the Korean-Okhotsk population, has been designated the Western North Pacific stock and is considered depleted (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017c; Cooke, 2019; Cooke et al., 2015; Weller et al., 2013; Weller et al., 2002). This subpopulation is listed under the ESA as endangered and there has been no critical habitat designated for Western North Pacific gray whales (Carretta et al., 2019c).

3.4.1.14.2 Abundance

The population size of the Eastern North Pacific gray whales has increased over several decades (Calambokidis et al., 2017a; Carretta et al., 2019c; Carretta et al., 2018a; Durban et al., 2017; Laake et al., 2012; Perryman et al., 2017). Monitoring over the last 30 years has provided data that have indicated the Eastern North Pacific population and stock is within range of its optimum sustainable population, which is consistent with a population approaching the carrying capacity of the environment (Carretta et al., 2018a; Carretta et al., 2017c; Laake et al., 2012). The current abundance estimate for the Eastern North Pacific stock is 26,960 gray whales (Carretta et al., 2019c), although the future trend for this population may be affected by the previously mentioned 2019 Unusual Mortality Event for the species (National Marine Fisheries Service, 2019b; National Oceanic and Atmospheric Administration, 2020a).

The Western North Pacific stock of gray whales was once considered extinct, but now small numbers (approximately 290) are known to exist (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017c; Cooke, 2019; Cooke et al., 2015; International Union for Conservation of Nature (IUCN), 2012; International Whaling Commission, 2014; Mate et al., 2015a; Nakamura et al., 2017; Weller et al., 2013). The documented high prevalence of rake marks from killer whale attacks on gray whales in the western North Pacific may represent an important selective pressure regulating the recovery of the stock (Weller et al., 2018). Current population trend data indicates a positive growth of roughly 2–5 percent per year up to and including 2017, when the most recent data was obtained (Carretta et al., 2019c; Carretta et al., 2018a; Cooke, 2019; Cooke et al., 2015; National Marine Fisheries Service, 2014). A recent increase in the occurrence of gray whales off Japan (Nakamura et al., 2017), is also consistent with a positive population growth for Western North Pacific gray whales. At least 12 members of the Western North Pacific stock have been detected in waters off the Pacific Northwest (Mate et al., 2013; Weller & Brownell, 2012). NMFS reported that 18 Western North Pacific gray whales have been identified in waters far enough south to have passed through Southern California waters (National Marine Fisheries Service, 2014), and although some gray whales have been shown to make mid-ocean migrations (Mate et al., 2015a), the Navy assumes that, for purposes of the acoustic effects modeling, migration to and from Southern California and Mexico would include passage through the NWTT Study Area as well. The current abundance estimate for the Western North Pacific stock is 290 gray whales (Carretta et al., 2019c; Carretta et al., 2018a).

3.4.1.14.3 Distribution

It should be noted that most of the science dealing with gray whale migrations and distribution is not specific to either of the two recognized gray whale sub-populations, but where possible that distinction has been specified in the following sections.

Along the Pacific coast between Alaska and Northern California, there are a few hundred gray whales present throughout the summer and fall that are known as the Pacific Coast Feeding Group, which are assumed to be part of the Eastern population (Calambokidis et al., 2002; Calambokidis et al., 2017b; Carretta et al., 2017c; Lemos et al., 2020; Mate, 2013; Mate et al., 2010; Weller et al., 2013). The group has been identified as far north as Kodiak Island, Alaska (Gosho et al., 2011), and has generated uncertainty regarding the stock structure of the Eastern North Pacific population (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017c; Weller et al., 2013; Weller et al., 2012). Survey and photo-identifications work undertaken along the Washington coast from 1984 to 2011 observed a total of 225 unique gray whales with 49 percent being observed again in a future year (Scordino et al., 2017). Photo-identification, telemetry, and genetic studies suggest that the Pacific Coast Feeding Group is a distinct feeding aggregation from the Eastern North Pacific population (Calambokidis et al., 2017b; Calambokidis et al., 2010; Frasier et al., 2011; International Whaling Commission, 2014; Lagerquist et al., 2018; Mate et al., 2010; Weller et al., 2013). In 2009 and 2012–2013, the Navy funded a satellite tracking study of Pacific Coast Feeding Group gray whales with tags attached to 35 gray whales off the coasts of Oregon and Northern California (Lagerquist et al., 2018; Mate, 2013). Feeding-area home ranges for the tracked whales covered most of the nearshore waters from Northern California to Icy Bay, Alaska, with most of the highest-use areas being outside the NWTT Study Area in the nearshore areas off Point St. George in Northern California, the central coast of Oregon, and the southern coast of Washington (Lagerquist et al., 2018; Mate, 2013). The satellite tag for these 35 whales indicated locations with 75 percent occurring less than 4.7 km from shore and 90 percent within 7.5 km of the shore (Lagerquist et al., 2018). Although the duration of the tags was limited, none of the Pacific Coast Feeding Group whales moved south beyond Northern California. The Pacific Coast Feeding Group is not currently treated as a distinct stock or population segment (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2015; Carretta et al., 2017c; Mate et al., 2010). Within the Inland Waters portion of the NWTT Study Area, there is also a group of gray whales that feed locally each spring in the inland waters around Whidbey Island and Camano Island (Cascadia Research, 2017e; Cogan, 2015). Five of the photo-identified individuals in this group have been seen over the last 17 years, and three have been sighted over at least 26 years (Cascadia Research, 2017e).

Gray whales of the Western North Pacific stock primarily occur in shallow waters over the U.S. West Coast, Russian, and Asian continental shelves and are considered to be one of the most coastal of the great whales (Jefferson et al., 2015; Jones & Swartz, 2009). Feeding grounds for the population are the Okhotsk Sea off Sakhalin Island, Russia, and in the southeastern Kamchatka Peninsula (in the southwestern Bering Sea) in nearshore waters generally less than 225 feet (ft.) deep (Jones & Swartz, 2009; Weller & Brownell, 2012). The winter breeding grounds for the Western North Pacific stock may be areas in the South China Sea (Weller et al., 2013). The breeding grounds for the Eastern North Pacific stock consist of subtropical lagoons in Baja California, Mexico (Alter et al., 2009; Jones & Swartz, 2009;

Mate et al., 2015a; Urban-Ramirez et al., 2003; Weller et al., 2012). Surveys in Russian waters have found the largest number of whales were observed in late August and early September (Meier et al., 2007), so the inference is that Western North Pacific gray whales will not be in the NWTT Study Area in those months.

Gray whales are acoustically active while migrating (Burnham et al., 2018; Guazzo et al., 2017), and acoustic, sighting, and satellite tag data have indicated that some gray whales use parts of the Washington coast throughout the year (Burnham et al., 2018; Emmons et al., 2017; Emmons et al., 2019a, 2019b; Ferguson et al., 2015b; Lagerquist et al., 2018). The Cetacean Density and Distribution Mapping Working Group (see Ferguson et al. (2015a) and (National Oceanic and Atmospheric Administration, 2019b)) shows the observed presence of gray whales in the Study Area in every month of the year except February. In aerial surveys conducted in waters off Washington, Oregon, and Northern California covering the approximate nearshore half of the Study Area in the spring, summer, and fall of 2011 and 2012, gray whales were present during all surveys and within 25 km of the coast except for two sightings over deeper water (Adams et al., 2014). In boat surveys between 1984 and 2011 off the Washington coast, gray whales were most commonly observed in very shallow waters with depths ranging from 5 to 15 m over rocky substrates and often near kelp forests (Scordino et al., 2017). This is consistent with the satellite location data from the subset of gray whales that have been tagged off the coast of Washington, Oregon, and California (Lagerquist et al., 2018).

Some gray whales make the longest annual migration of any mammal, 15,000–20,000 km roundtrip (Jones & Swartz, 2009; Mate et al., 2013; Mate et al., 2015a; Weller et al., 2013; Weller et al., 2012). Both the western and eastern populations are now known to overlap in both the northern feeding grounds and in the breeding areas (Weller et al., 2013), so while most gray whales migrating through the Study Area are likely from the eastern population, individuals from the western population may also be present (Carretta et al., 2019c; Carretta et al., 2017c). Long-term studies of radio-tracked whales, improved photographic identification, and genetic studies have detected western population whales along the North American coast from British Columbia, Canada, and as far south as Baja California, Mexico (Mate et al., 2015a; Muir et al., 2016; Weller et al., 2013; Weller et al., 2002; Weller et al., 2012). For purposes of the analysis in this Supplemental, it is assumed that a very small percentage of migrating gray whales could be individuals from the endangered Western North Pacific stock.

Gray whales that migrate do so between October and July (Calambokidis et al., 2015) and the majority of gray whales are only present in the Study Area while migrating through those waters. Gray whale individuals identified and observed along the Washington coast had an average minimum residency time in those waters of approximately 25 days out of a possible 183 days of the feeding season (Scordino et al., 2017); satellite tag data from 35 whales in 2009, 2012, and 2013 indicated a high number of area restricted search feeding activity nearshore off Barkley Sound, British Columbia (Lagerquist et al., 2018), which is to the north of the NWTT Study Area in Canadian waters.

The gray whale migration corridors, a potential presence migration buffer, and the months they are cumulatively in use (October through July) were identified as biologically important areas that should be considered given the potential for human activities to impact this important seasonal migration behavior (Calambokidis et al., 2015; Ferguson et al., 2015a; Ferguson et al., 2015b; Van Parijs, 2015); see the 2015 NWTT Final EIS/OEIS, Figure 3.4-3. As noted previously, the northern boundary of designated biologically important areas were truncated at a line drawn between the U.S. and Canadian EEZs because the identification of biologically important areas was restricted to locations only in U.S. waters (Calambokidis et al., 2015; Ferguson et al., 2015b). Gray whale migration corridors are contiguous from

U.S. waters through Canadian waters (Burnham et al., 2018; Ford et al., 2010), and continue on into waters off Alaska (Ferguson et al., 2015a). In the designation of BIAs to only locations only in U.S. waters, it was made clear that, "…the absence of BIA designations outside U.S. waters should not be interpreted as an absence of BIAs in those waters" (Ferguson et al., 2015b), which is the case for the gray whale migration routes that extend through the NWTT Study Area and northward into Canadian waters, and beyond to Alaska. Calambokidis et al. (2015) designated the months the gray whale migration BIA is in use, but those months (October through July) characterize the majority of a gray whale migration phase start from feeding locations in Alaska waters or from breeding locations in Mexico. For example, the first whales departing northern waters (on the Southbound Phase) have been documented as showing up off Granite Canyon, California (the shore-based counting location south of Carmel) in early December for decades (Durban et al., 2017; Laake et al., 2012). This means that the first gray whales heading south will have passed through the NWTT Study Area portion of their migration sometime in November. For the northward route, gray whales are encountered off Southern California in the April–June timeframe (Graham & Saunders, 2015; Guazzo et al., 2019). As a result, the portion of the migration BIA in the NWTT Study Area would likely be in use for the main influx of southward migrations in the November-December timeframe and for northward migrations in the May-July timeframe. The Navy's acoustic effects modeling assumes some gray whales (likely transient non-breeding juveniles) may be present in the NWTT Study Area outside the main migration period patterns, but do not constitute a significant portion of any gray whale population. Therefore, and for purposes of the analysis presented in this document, the Navy assumes that small numbers of gray whales may be present year round and that larger numbers would be migrating through the Study Area in the early winter and late spring.

Analysis of Navy training and testing activities in relation to these biologically important areas for gray whale migration was previously completed in the 2015 NWTT Final EIS/OEIS (U.S. Department of the Navy, 2015a), evaluated by NMFS in the issuance of the current Letter of Authorization pursuant to the MMPA (National Oceanic and Atmospheric Administration, 2015b), and reviewed by NMFS pursuant to ESA for listed species in the Study Area (National Marine Fisheries Service, 2014). There is no new applicable science that necessitates any changes in those previous analyses. For additional details regarding these analyses, see Section 3.4.2.1 (Acoustic Stressors) and Appendix K (Geographic Mitigation Assessment) in this Supplemental, as well as the 2015 NWTT Final EIS/OEIS (U.S. Department of the Navy, 2015a).

In addition to the gray whale migration routes, the distribution of gray whales in the Study Area is driven by the presence of known feeding areas. When feeding in Washington waters, gray whales were most often observed in depths between 5 and 15 m in either kelp forests or emergent offshore rocks (Scordino et al., 2017). While there are important gray whale feeding areas just to the north of the Offshore portion of the NWTT Study Area in Canadian waters (see for example, Burnham and Mouy (2019)), there are six feeding locations designated as a biologically important area in U.S. waters in the Pacific Northwest (Calambokidis et al., 2015). Of those six areas, only the Northwestern Washington and the Northern Puget Sound feeding areas are within the Study Area (see the 2015 NWTT Final EIS/OEIS, Figure 3.4-4). Evaluation of Navy training and testing activities in relation to these biologically important feeding areas for gray whale was previously completed in the 2015 NWTT Final EIS/OEIS (U.S. Department of the Navy, 2015a), evaluated by NMFS in the issuance of the current Letter of Authorization pursuant to the MMPA (National Oceanic and Atmospheric Administration, 2015b), and reviewed by NMFS pursuant to ESA for listed species in the Study Area (National Marine Fisheries Service, 2014). There is no new applicable science that necessitates any changes in those previous analyses. For additional details regarding these analyses, see Section 3.4.2.1 (Acoustic Stressors) and Appendix K (Geographic Mitigation Assessment) in this Supplemental as well as the 2015 NWTT Final EIS/OEIS (U.S. Department of the Navy, 2015a). Research that has emerged since the previous analysis suggests that gray whales have the capacity to depress localized feeding area prey abundance, although the prey populations have demonstrated the capacity to recover over periods of one to three years (Burnham & Duffus, 2018). This provides additional indication of the dynamic nature of gray whale feeding areas from year to year, which over short time scales (e.g., one to three years) may not be well represented by the presence of one or more statically bounded and designated feeding areas.

Offshore. The occurrence of gray whales is considered seasonal and likely in the offshore portion of the Study Area (Calambokidis et al., 2017b). In 42 small boat surveys from Grays Harbor out to the 1,000 m isobath off Quinault conducted in the summer over a five-year period between 2004 and 2009, there were eight sightings of gray whales (Oleson & Hildebrand, 2012). As noted previously, aerial surveys conducted in waters off Washington, Oregon, and Northern California in the spring, summer, and fall of 2011 and 2012 found gray whales present during all surveys periods (Adams et al., 2014). The seasonal increase in the number of gray whales likely to be present in the area while feeding and migrating have been accounted for in the analysis. Four of the five seasonal gray whale feeding areas located along the West Coast of the United States are near but not within the Offshore portion of the Study Area (Aquatic Mammals, 2015; Calambokidis et al., 2015). The fifth feeding area—the Northwest Washington feeding area—partially overlaps with the Offshore Area, as shown on Figure 3.4-4 in the 2015 NWTT Final EIS/OEIS. This area is identified as important for feeding gray whales from May through November (approximately seven months) (Calambokidis et al., 2015). Gray whales satellite tagged off the coasts of Oregon and Northern California also had a high-use extended residence area north of the entrance of the Strait of Juan de Fuca (and the NWTT Study Area) off the coast of Vancouver Island extending from Barkley Sound and north along that coast (Lagerquist et al., 2018), but that area just over the border off Canada would not have been considered in the previous analysis of important areas, since it was not within U.S. waters (Ferguson et al., 2015b).

Inland Waters. As gray whales migrate between feeding and breeding grounds, a few enter the Strait of Juan de Fuca to feed in Inland Waters (Cascadia Research, 2017e; Cogan, 2015). Based on data collected 1984 to 2011 during the feeding season the observation rate increased to a peak in October in the Strait of Juan de Fuca (Scordino et al., 2017). Gray whales have been detected in Washington inland waters in all months of the year, with peak abundance from March through June (Calambokidis et al., 2017b; Calambokidis et al., 2010). Typically fewer than 20 gray whales are documented annually in the inland waters of Washington and British Columbia, based on a review of Orca Network (Calambokidis et al., 2015; Cogan, 2015; Washington Department of Fish and Wildlife, 2013). For purposes of the analysis in this Supplemental, gray whales in the Inland Waters portion of the Study Area are considered to have a seasonal presence.

The identified a gray whale "Potential Presence" migration area extends into and includes all U.S. waters from the entrance of the Strait of Juan de Fuca landward (Calambokidis et al., 2015). This portion of the Potential Presence migration area therefore overlaps all the Inland Waters portion of the Study Area. As noted previously, this Potential Presence area is identified as seasonally important from January through July, and October through December; approximately 10 months of the year. In addition, a biologically important feeding area also has been identified in northern Puget Sound located south and east of Whidbey Island and east of Camano Island to Everett (Calambokidis et al., 2015). This feeding area is used in the spring for 2–3 months, typically beginning in March and generally ending by June

(Calambokidis et al., 2015). For further detailed discussion of these gray whale biologically important feeding areas in the Inland Waters portion of the Study Area, see Section 3.4.2.1 (Acoustic Stressors) in this Supplemental as well as the 2015 NWTT Final EIS/OEIS (U.S. Department of the Navy, 2015a).

Western Behm Canal, Alaska. Gray whales were not observed during 1991–2007 surveys of the inland waters of southeast Alaska (Dahlheim et al., 2009), and they are considered extralimital in this region of the Study Area. There are no identified gray whale feeding or migration areas near the Western Behm Canal; the closest being approximately 60 NM to the southwest and out along the Pacific Coast of Southeast Alaska near Dixon Entrance (Ferguson et al., 2015a).

Odontocetes

3.4.1.15 Common Bottlenose Dolphin (*Tursiops truncatus*)

3.4.1.15.1 Status and Management

The common bottlenose dolphin is not listed under the ESA. For bottlenose dolphins within the Pacific U.S. EEZ there are seven stocks, but only the California, Oregon, and Washington offshore stock is occasionally present in the Offshore portion of the Study Area as part of their recognized range (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017c). The California, Oregon, and Washington stock is not considered depleted under the MMPA.

3.4.1.15.2 Abundance

Based on surveys from 1991 to 2008, the abundance for bottlenose dolphins in the Northern California portion of the Study Area is estimated at 253 animals and is 0 for the more northern Oregon/Washington stratum; the species was not detected in the Study Area in 2014 (Barlow, 2016).

3.4.1.15.3 Distribution

Bottlenose dolphins are found most commonly in coastal and continental shelf waters of tropical and temperate regions of the world; the primary range of the California, Oregon, and Washington stock is south of approximately 38°N (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017c). Based on habitat models derived from line-transect survey data collected between 1991 and 2009 off the U.S. West Coast, very low densities of bottlenose dolphins are predicted north of approximately 40°N during the summer and fall (Becker et al., 2016). Bottlenose dolphins are expected to expand their range north into Oregon and Washington waters during El Niño events, when water temperatures increase in the area (Cascadia Research Collective, 2011a). A mixed-species group of approximately 200 bottlenose dolphins and 70 false killer whales was observed 500 km north of the Strait of Juan de Fuca and 180 km off the coast of British Columbia (at approximately 50°N) on July 29, 2017, which was suggested to have been associated with the prolonged period of ocean warming along the Pacific Coast (Halpin et al., 2018).

Offshore. Off the U.S. West Coast, bottlenose dolphins are generally encountered south of approximately 41°N (Adams et al., 2014; Barlow, 2016; Hamilton et al., 2009). In September 2012, a pod of four bottlenose dolphins was encountered during an aerial survey off Grays Harbor (Adams et al., 2014). For purposes of this analysis, bottlenose dolphins are considered to have a regular occurrence in the Offshore portion of the Study Area.

Inland Waters. Bottlenose dolphins are considered extralimital in the Inland Waters portion of the Study Area. Prior to 2017, there had been one bottlenose dolphin stranding and only occasional sightings, generally consisting of lone individuals, within the Salish Sea (Cascadia Research Collective, 2011a; National Marine Fisheries Service, 2017a; U.S. Department of the Navy, 2017h). In the fall of 2017, a group of bottlenose dolphins was sighted repeatedly in Puget Sound, which is unusual given the species tends to be found in areas with warmer temperature as opposed to cold-water areas such as the Pacific northwest (Cascadia Research, 2017c). One animal in the group was photo-identified as a well-known dolphin first sighted in Southern California in 1983, belonging to the California Coastal stock of bottlenose dolphins, but which the evidence suggests has been part of a group incrementally expanding the northern range of the stock (Cascadia Research, 2017c). The Navy does not expect the temporary presence of these California Coastal stock animals to reflect a permanent expansion northward for these animals.

Western Behm Canal, Alaska. Given the species preference for warmer water habitat, bottlenose dolphins are not expected to occur within the Behm Canal portion of the Study Area.

3.4.1.16 Killer Whale (*Orcinus orca*)

3.4.1.16.1 Status and Management

For the populations of killer whales present in the Study Area, only the Southern Resident population is listed as endangered under the ESA; the remaining populations are not listed under the ESA (Carretta et al., 2019c; Carretta et al., 2018b). NMFS designated critical habitat for Southern Resident killer whales totals 2,560 square miles that includes Haro Strait and the waters around the San Juan Islands, Puget Sound, and the Strait of Juan de Fuca, but does not include any of Hood Canal or locations where the water depth is less than 20 ft. (6.1 m) (National Marine Fisheries Service, 2016h; National Marine Fisheries Service: Northwest Region, 2006; National Oceanic and Atmospheric Administration, 2014a). Eighteen sites[5] owned or controlled by the Department of Defense are excluded from this critical habitat designation, including Navy installations within Puget Sound. The NMFS identified primary constituent elements essential for conservation of the Southern Resident killer whale critical habitat as (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging (National Marine Fisheries Service: Northwest Region, 2006). There have been concerns over impacts to Southern Resident killer whales in this critical habitat resulting from whale watching vessel disturbance (Ferrara et al., 2017; Giles & Koski, 2012; Holt et al., 2017; Lacy et al., 2017; National Marine Fisheries Service, 2016h, 2018e; Seely et al., 2017; Tollit et al., 2017), commercial shipping noise (Cominelli et al., 2018; Tollit et al., 2017; Veirs et al., 2016; Williams et al., 2019), and prey availability (Ford et al., 2016; Groskreutz et al., 2019; Hanson et al., 2010; Hilborn et al., 2012; National Marine Fisheries Service, 2016h; National Marine Fisheries Service West Coast Region & Washington Department of Fish and Wildlife, 2018; Nattrass et al., 2019; Ruggerone et al., 2019; Shields et al., 2018b; Trites & Rosen, 2018;

[5] As provided in the final rule establishing the critical habitat for Southern Resident killer whales, the designated critical habitat does not include the following 18 areas owned or controlled by the Department of Defense, or designated for its use, in the State of Washington, including shoreline, nearshore areas around structures such as docks and piers, and marine areas: (1) Naval Undersea Warfare Center, Keyport; (2) Naval Ordnance Center, Port Hadlock (Indian Island); (3) Naval Fuel Depot, Manchester; (4) Naval Air Station, Whidbey Island; (5) Naval Station Everett; (6) Naval Hospital Bremerton; (7) Fort Lewis (Army); (8) Pier 23 (Army); (9) Puget Sound Naval Ship Yard; (10) Strait of Juan de Fuca naval air-to-surface weapon range, restricted area; (11) Strait of Juan de Fuca and Whidbey Island naval restricted areas; (12) Admiralty Inlet naval restricted area; (13) Port Gardner Naval Base restricted area; (14) Port Orchard Passage naval restricted area; (15) Sinclair Inlet naval restricted area; (16) Carr Inlet naval restricted area; (17) Port Townsend/Indian Island/Walan Point naval restricted area; and (18) Crescent Harbor Explosive Ordnance Units Training Area.

Ward et al., 2013; Wasser et al., 2017). Tollit et al. (2017) modeled the potential disturbance from vessel noise in the core of the Southern Resident killer whale critical habitat and predicted large commercial vessel noise would result in approximately seven low severity and three moderate severity behavioral responses per day per southern resident killer whale, with whale watch boat noise contributing an additional 7 percent to behavioral response related potential lost foraging time for the species.

The use of the Inland Waters portion of the NWTT Study Area by Southern Resident killer whales has declined in recent years as they shift their range and forage for Chinook salmon or other prey species elsewhere and outside the currently designated critical habitat in response to prey availability (Ruggerone et al., 2019; Shields et al., 2018b). In 2014, NMFS received a petition to revise the existing Southern Resident killer whale critical habitat (National Oceanic and Atmospheric Administration, 2014a). In 2015, NMFS found the revision warranted given tag data demonstrating the species also spends considerable time outside the inland waters of the Pacific Northwest while inhabiting nearshore areas along the Washington/Oregon/California coastline ((National Oceanic and Atmospheric Administration, 2014a); see also Riera et al. (2019)). In 2019, NMFS published a proposal to expand the 2006 designated Southern Resident killer whale critical habitat by including 15,627 NM^2 of marine waters along the U.S. West Coast between the 20 ft. depth contour and the 656 ft. depth contour, from the U.S. international border with Canada south to Point Sur, California (84 FR 49214). The proposed expansion is intended to incorporate the seasonal shift in Southern Resident killer whale distribution (Cogan, 2015; Dahlheim et al., 2008; Ford et al., 2014; Hanson et al., 2015; Houghton et al., 2015a; National Marine Fisheries Service, 2016h, 2019f, 2019g; National Oceanic and Atmospheric Administration, 2011, 2014b; Rice et al., 2017), including as far south as Monterey Bay and central California where K1 and L1 pods have been sighted in recent years (Carretta et al., 2018b; Millman, 2019). The Navy has incorporated analysis of proposed changes to Southern Resident killer whale critical habitat into the analysis presented in this Supplemental in Section 3.4.2 (Environmental Consequences) and is conferencing with NMFS under ESA on the proposed critical habitat.

The governor of Washington has also directed state agencies to implement certain actions to benefit Southern Resident killer whales based on threats to the species as identified in a report by the Southern Resident Orca Task Force (Office of the Washington Governor, 2018). The major threats to Southern Resident killer whales identified in the report are a lack of prey, disturbance from noise and vessel traffic, and toxic contaminants in the waters they inhabit; Navy actions were not the sources for any of these identified threats although there were concerns over the geographic exemption for military activities off the coast that overlap with the distribution of the Southern Resident orcas (Office of the Washington Governor, 2018; Southern Resident Orca Task Force, 2019).

Seven killer whale stocks are recognized in the Eastern North Pacific: (1) the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock (Prince William Sound through the Aleutian Islands and Bering Sea); (2) the AT1 Transient stock (Alaska from Prince William Sound through the Kenai Fjords); (3) the Eastern North Pacific Alaska resident stock (southeastern Alaska to the Aleutian Islands and Bering Sea); (4) the Eastern North Pacific Northern Resident stock (Washington State through part of southeastern Alaska); (5) the West Coast Transient stock (Alaska through California); (6) the Eastern North Pacific Offshore stock (southeast Alaska through California); and (7) the Eastern North Pacific Southern Resident stock (mainly within the inland waters of Washington State and southern British Columbia, but also in coastal waters from southeast Alaska through California) (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). As shown in the NMFS SARs, out of these seven stocks there are five (Alaska Resident, Northern Resident, West Coast

Transient, Offshore, and Southern Resident stocks) that may be present in the Study Area. Out of those five stocks, only the Southern Resident stock is considered depleted under the MMPA (Carretta et al., 2019c; Carretta et al., 2018b; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a).

3.4.1.16.2 Abundance

The abundance estimates from NMFS for the five killer whale stocks expected to occur in the Study Area are as follows: Alaska Resident stock = 2,347 animals; Northern Resident stock = 261 animals; West Coast Transient stock = 243 animals; Offshore stock = 300 animals; and Southern Resident stock = 77 individuals (Carretta et al., 2019c; Carretta et al., 2018a, 2018b; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). The West Coast transient population of killer whales has more than doubled in size since 1990 (Towers et al., 2018a). For the Offshore portion of the Study Area and based on summer/fall surveys undertaken by NMFS from 1996 to 2014, the abundance of killer whales in the area (the combined Oregon/Washington stratum and the Northern California stratum) is estimated at 224 animals (Barlow, 2016). This abundance estimate is for animals from the Offshore and West Coast Transient stocks present in U.S. waters (Carretta et al., 2019c; Carretta et al., 2018a, 2018b; Carretta et al., 2017c; Muto et al., 2018b; Muto et al., 2019a). In the 2018 Pacific Stock Assessment Report regarding the Offshore stock of killer whales, NMFS concluded, “The fraction of this population that utilizes U.S. waters at any one time is unknown and the number of animals that utilize areas outside of the currently known geographic range (Aleutian Islands to Southern California) is also unknown” (Carretta et al., 2019c; Carretta et al., 2018a). With regard to the number of Southern Resident killer whales, the Navy is aware of the information presented in the report by the Southern Resident Orca Task Force indicating the population numbering 74 individuals as of the end of November 2018 (Office of the Washington Governor, 2018) and various other counts from other sources since (National Marine Fisheries Service, 2020), but the Navy has based the analysis for the Offshore area on the count (a minimum population estimate of 75) provided by NMFS in the most recent draft SAR for 2019 (Carretta et al., 2019c).

3.4.1.16.3 Distribution

Killer whales are found in all marine habitats from the coastal zone, including most bays and inshore channels, to the deep ocean and from equatorial regions to the polar pack ice zones of both hemispheres (Dahlheim et al., 2008; Forney & Wade, 2006; Garcia et al., 2016; Hanson et al., 2017; Wiles, 2016). Some killer whales such as the Southern Residents have seasonal shifts in distribution from the inland waters of the Salish Sea and Puget Sound to locations that can be up to hundreds of miles both north or south of the Study Area (Cogan, 2015; Dahlheim et al., 2008; Ford et al., 2014; Hanson et al., 2018; Hanson et al., 2015; Houghton et al., 2015a; National Marine Fisheries Service, 2016h; National Oceanic and Atmospheric Administration, 2011, 2014b; Olson et al., 2018; Rice et al., 2017; Riera et al., 2019). The Southern Resident K and L pods have been sighted as far south as Monterey Bay and central California in recent years, and L Pod has been documented as far north as Chatham Strait in Southeast Alaska (Carretta et al., 2019c; Carretta et al., 2018b; Millman, 2019).

Distributions of killer whales are somewhat associated with the killer whale ecotypes, and all three ecotypes (offshore, transients, and residents) are known to occur in the Study Area (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017c; Cogan, 2015; Debich et al., 2014; Ford et al., 2014; Ford et al., 2013; Hanson et al., 2018; Hanson et al., 2017; Kerosky et al., 2013; Muto et al., 2017; National Marine Fisheries Service, 2016h; National Marine Fisheries Service: Northwest Region, 2006;

Oleson et al., 2009; Oleson & Hildebrand, 2012; Rice et al., 2017; Riera et al., 2019; Širović et al., 2012a; Trickey et al., 2015; Wiles, 2016).

Offshore. In the Offshore portion of the Study Area, there are variable seasonal distributions for all three killer whale ecotypes and associated stocks, which overlap in many cases. Details regarding these distributions, the seasonal variation, and overlap within sub-areas are presented in the NWTT Marine Species Density Database Technical Report (U.S. Department of the Navy, 2020). In general for the offshore area, the stocks present may include the Offshore, West Coast Transient, Northern Resident, and Southern Resident stocks depending on the season and the distance from shore (Debich et al., 2014; Emmons et al., 2019b; Fisheries and Oceans Canada, 2015a; Ford et al., 2014; Ford et al., 2013; Hanson et al., 2018; Hanson et al., 2017; Kerosky et al., 2013; National Marine Fisheries Service, 2016h; National Marine Fisheries Service: Northwest Region, 2006; Oleson et al., 2009; Oleson & Hildebrand, 2012; Rice et al., 2017; Riera et al., 2019; Širović et al., 2012a; Trickey et al., 2015; Wiles, 2016).

To better predict the pattern of distribution of the endangered Southern Resident killer whales off the British Columbia, Washington, Oregon, and California coasts, researchers integrated visual sightings, location data obtained between 2012 and 2016 from satellite-tagged Southern Resident killer whales, and acoustic detections from underwater hydrophones deployed variously at 19 locations from 2008 to 2017 off the Washington, Oregon, and California coast (Emmons et al., 2019a, 2019b; Hanson et al., 2018; U.S. Department of the Navy, 2018a). Along the Pacific coast, the distribution of satellite-tag locations confirms that Southern Resident killer whales generally inhabit nearshore waters and over multiple years have spent the highest amount of time near the mouth of the Columbia River and Westport, Washington (Hanson et al., 2018; Hanson et al., 2017; U.S. Department of the Navy, 2018a) These high-use areas at mouth of Columbia River and Westport are centered far inshore of the Study Area boundary; the NWTT Study Area boundary is located 12 NM from the coast off this area of Washington and off all of Oregon and California. Satellite tag data indicated that when along the Pacific coast, Southern Resident killer whales spent only about 15 percent of their time in the NWTT Study Area, and on those occasions had median visit duration of approximately 13 hours (Hanson et al., 2017). At the northern extreme of the NWTT Study Area off Washington, Southern Resident killer whales have been acoustically detected by monitoring hydrophones as far as 62 km out to sea off Cape Flattery, but based on satellite tag data are only found that far out to sea approximately 5 percent of the time when offshore (Emmons et al., 2019a, 2019b; Hanson et al., 2018; U.S. Department of the Navy, 2018a). Acoustic data recorded between 2008 and 2017 indicated that the Southern Residents were most frequently in the nearshore waters off Sand Point and La Push, where the hydrophones were respectively at only 7 km and 4 km from shore, when considering the northern part of the NWTT Study Area (Emmons et al., 2019a, 2019b). Just north of the NWTT Study Area and the U.S. border, off the southwest coast of Vancouver Island, Canada, both Northern and Southern Resident killer whales were routinely acoustically detected on hydrophones deployed offshore at Swiftsure Bank from 2009 to 2011 (Riera et al., 2019). The general area around entrance to the Strait of Juan de Fuca (inclusive of the waters off Cape Flattery and at Swiftsure Bank) sampled by these hydrophone recordings is the location of the semi-permanent and highly productive eddy associated with the outflow from the strait. The area has a high density of Chinook salmon and despite intense vessel traffic and noise associated with some of the busiest ports in North America, the area is routinely used by both Southern Resident and Northern Resident killer whales throughout the year (Dalla-Rosa et al., 2012; Emmons et al., 2019b; MacFadyen et al., 2008; Riera et al., 2019; U.S. Maritime Administration, 2016). Well beyond the boundaries or even the vicinity of the NWTT Study Area, Southern Resident killer whales in L pod have been documented as far north as Chatham Strait in Southeast Alaska, and individuals from both K pod and L pod have been sighted as far south as Monterey Bay and Central California in recent years (Carretta et al., 2019c; Carretta et al., 2018b; Millman, 2019).

Inland Waters. The killer whale stocks present in the Inland Waters portion of the Study Area may include the West Coast Transient, Northern Resident, and Southern Resident stocks depending on the season and the sub-area within the inland waters (Cogan, 2015; Ford et al., 2014; Ford et al., 2013; Hanson et al., 2017; National Marine Fisheries Service, 2016h; National Marine Fisheries Service: Northwest Region, 2006; Olson et al., 2018; Smultea et al., 2017; Wiles, 2016). Details regarding these distributions, the seasonal variation, and overlap within sub-areas of the inland waters were provided in the 2015 NWTT Final EIS/OEIS and are incorporated as appropriate into the NWTT Marine Species Density Database Technical Report (U.S. Department of the Navy, 2020). A summary and supplemental update of the discussion from the 2015 NWTT Final EIS/OEIS is provided in the paragraphs below using updated references not available at the time.

Transient killer whales in the Pacific Northwest spend most of their time along the outer coast of British Columbia and Washington, but they visit inland waters in search of harbor seals, sea lions, and other prey (Cogan, 2015; Ford & Ellis, 1999; Ford et al., 2013; Rice et al., 2017; Wiles, 2016). Transients may occur in inland waters in any month (Cogan, 2015; Ford et al., 2013; Kriete, 2007; Rice et al., 2017). The number of West Coast Transient killer whale occurrences in inland waters increased between 1987 and 2010, possibly because the abundance of some prey species (e.g., seals, sea lions, and porpoises) had increased (Houghton et al., 2015a; Shields et al., 2018a). Over the last 14 years, transient killer whale numbers in the Salish Sea have continued to increase, with 2017 having the record as the most sightings in a single year (Shields et al., 2018a).

Individuals of the Northern Resident stock are occasionally present in the Strait of San Juan de Fuca Inland Waters portion of the Study Area (Cogan, 2015; Wiles, 2016; Wright et al., 2017b).

The Southern Resident stock inhabits both inland Washington and southern British Columbia waters and offshore waters along the coast of the U.S. and Canada (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017d; Emmons et al., 2019b; Hanson et al., 2018; National Marine Fisheries Service, 2016h; Riera et al., 2019). Photo-identification of individual whales through the years, as well as more recent satellite tagging and passive acoustic monitoring, has resulted in a substantial understanding of this stock’s structure, behaviors, and movements in relation to the NWTT Study Area (Emmons et al., 2019a, 2019b; Hanson et al., 2018; Riera et al., 2019; Wiles, 2016; Wright et al., 2017b). In spring and summer months, the Southern Resident stock is most frequently seen in the San Juan Islands region with intermittent sightings and detections in Puget Sound and offshore (Olson & Osborne, 2017; Olson et al., 2018; Riera et al., 2019; Shields et al., 2018b), which is consistent with the “summer core area” identified during the establishment of the critical habitat for the species. In the fall and early winter months, the Southern Residents are seen more frequently in Puget Sound, where returning chum, steelhead, and Chinook salmon are concentrated; Chinook are targeted preferentially when available (Ford et al., 2009a; Ford et al., 2016; Hanson et al., 2018). By winter, they spend progressively less time in the inland marine waters and more time off the coast of Washington, Oregon, and California (Black, 2011; Cogan, 2015; Emmons et al., 2019a, 2019b; Hanson et al., 2017; National Marine Fisheries Service, 2016h; Olson & Osborne, 2017; Riera et al., 2019). As noted previously, the use of the Inland Waters portion of the NWTT Study Area by Southern Resident killer whales has declined in recent years as they shift their range in response to reduced prey availability in Puget Sound (Nelson et al., 2019; Olson & Osborne, 2017; Olson et al., 2018; Shields et al., 2018b).

While both Southern Resident killer whales and transient killer whales are frequently sighted in the main basin of Puget Sound, their presence near Navy installations varies from not present at all to infrequent sightings, depending on the season (Olson & Osborne, 2017; Olson et al., 2018). As was detailed in the 2015 NWTT Final EIS/OEIS, Section 3.4.2.15.3 (Distribution), Southern Resident killer whales have not been reported in Hood Canal or Dabob Bay since 1995; transient killer whales were observed in Hood Canal in 2003 and 2005 (National Marine Fisheries Service: Northwest Region, 2006), but there were no reports of subsequent visits to those waters until May 2018 (The Seattle Times, 2018). Near Naval Base Kitsap Bremerton and Keyport, the Southern Resident killer whale is also rare, with the last confirmed sighting in Dyes Inlet in 1997 (Navy has assumed transients will occasionally be present in these areas). Both Southern Resident killer whales and transients have been observed in Saratoga Passage and Possession Sound near Naval Air Station Whidbey Island and Naval Station Everett, respectively. Transients and Southern Resident killer whales have also been observed in southern Puget Sound in the Carr Inlet area.

Western Behm Canal, Alaska. In Southeast Alaska including the Behm Canal, the Alaska Resident, Offshore, and Transient stock ecotypes are present based on the assigned stocks in the Alaska SAR (Dahlheim et al., 2009; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). Killer whales from the Transient stock are considered rare in the Behm Canal region of the Study Area (Dahlheim et al., 2009). Northern Resident killer whales have been documented in southeast Alaska, although in the summer they are found primarily in central and northern British Columbia (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). Therefore, individuals belonging to the Alaska Resident stock are the killer whales most likely to occur in the SEAFAC region of the Study Area, and are more likely from spring through fall (Dahlheim et al., 2009). Southern Resident killer whales (L pod, 30 individuals) were photographically identified in Chatham Strait, Southeast Alaska (northwest of Behm Canal), in June 2007. Southern Residents were previously thought to range as far north as the Queen Charlotte Islands, BC; however, this sighting extended their known range about 200 miles to the north (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2016c).

3.4.1.17 Northern Right Whale Dolphin (*Lissodelphis borealis*)

3.4.1.17.1 Status and Management

Northern right whale dolphins are not considered a threatened or endangered species under the ESA and are not considered depleted under the MMPA. Northern right whale dolphins are present in the Offshore portion of the Study Area, and those animals have been assigned to the California, Oregon, Washington stock (Carretta et al., 2018a; Carretta et al., 2017c).

3.4.1.17.2 Abundance

The most recent NMFS survey in 2014 found northern right whale dolphin abundance higher than in the previous three surveys between 2001 and 2008 (Barlow, 2016). For the Offshore portion of the Study Area and based on surveys from 1996 to 2014, the abundance for northern right whale dolphins in the area (the combined Oregon/Washington stratum and the Northern California stratum) is estimated at 17,228 animals (Barlow, 2016).

3.4.1.17.3 Distribution

The northern right whale dolphin occurs in cool-temperate to subarctic waters of the North Pacific Ocean, from the west coast of North America to Japan and Russia (Jefferson et al., 2015). The species does not migrate, although shifts in abundance and distribution may vary seasonally or between years (Barlow, 2016; Becker et al., 2014; Dohl et al., 1983; Douglas et al., 2014; Forney & Barlow, 1998;

Jefferson et al., 2015). Based on habitat models developed with line-transect survey data collected off the U.S. West Coast during summer and fall from 1991 to 2009, Becker et al. (2016) found that encounters of northern right whale dolphin increased in shelf and slope waters, and encounters decreased substantially in waters warmer than approximately 64°F (18°C).

In the NMFS 2014 survey of the U.S. West Coast, all of the sightings of northern right whale dolphins were in the Oregon/Washington stratum, which is indicative of a distributional shift to the north in comparison to the species' previous distributions during three surveys undertaken between 2001 and 2008 (Barlow, 2016). Although the NMFS surveys provide limited coverage for nearshore waters, aerial surveys conducted in the approximate nearshore half of the Study Area in 2011 and 2012 (Adams et al., 2014) were consistent with the findings from 2014 NMFS survey.

Offshore. Aerial surveys conducted in waters off southern Washington, Oregon, and Northern California covering the approximate nearshore half of the Study Area in the spring, summer, and fall of 2011 and 2012 found that northern right whale dolphins were approximately the second-most frequently detected marine mammal in the area (Adams et al., 2014). For purposes of the analysis in this Supplemental, Northern right whale dolphins are considered to have a regular presence in the Offshore portion of the Study Area.

Inland Waters. Northern right whale dolphins are considered extralimital in the Inland Waters portion of the Study Area based on past sightings and stranding records (National Marine Fisheries Service, 2017a; U.S. Department of the Navy, 2017h).

Western Behm Canal, Alaska. Northern right whale dolphins are not expected to occur within the Behm Canal portion of the Study Area based on surveys conducted in Southeast Alaska from 1991 to 2007 (Dahlheim et al., 2009).

3.4.1.18 Pacific White-Sided Dolphin (*Lagenorhynchus obliquidens*)

3.4.1.18.1 Status and Management

Pacific white-sided dolphins are not considered a threatened or endangered species under the ESA, and neither stock in the Study Area is considered depleted under the MMPA. Pacific white-sided dolphin in the Behm Canal portion of the Study Area are from the North Pacific stock (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a) and those in the Offshore and Inland Waters portion are from the California, Oregon, Washington stock (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017c).

3.4.1.18.2 Abundance

Although the species was sighted in relatively high numbers in Southeast Alaska (Dahlheim et al., 2009), there is no estimate of a specific abundance for Pacific white-sided dolphins in the Behm Canal or the broader Southeast Alaska region. The stock assigned to Pacific white-sided dolphin is for all animals in the North Pacific north of 45° North from Southeast Alaska to the Aleutian Islands (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). Based on marine mammal sighting data collected in the North Pacific from 1987 to 1990, the population for the Alaska area covered by the SAR is 26,880 individuals although the total population was estimated to have an abundance of 931,000 individuals (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a).

In the 2014 NMFS survey that included the NWTT Offshore area, Pacific white-sided dolphin abundance was fairly typical of their abundance in the previous three surveys between 2001 and 2008 (Barlow, 2016). For the Offshore portion of the Study Area based on surveys from 1991 to 2014, the abundance of Pacific white-sided dolphins in the area (the combined Oregon/Washington stratum and the Northern California stratum) is estimated at 18,680 animals (Barlow, 2016).

3.4.1.18.3 Distribution

Pacific white-sided dolphins are found in cold temperate waters across the northern rim of the Pacific Ocean as far north as the southern Bering Sea and as far south as the Gulf of California off Mexico (Dahlheim et al., 2009; Ferguson, 2005; Hamilton et al., 2009; Jefferson et al., 2015; Leatherwood et al., 1984; Reeves et al., 2002b). The species is also known to inhabit inshore regions of southeast Alaska, British Columbia, and Washington (Brownell et al., 1999; Dahlheim et al., 2009; Forney & Barlow, 1998; U.S. Department of the Navy, 2017h; Williams & Thomas, 2007).

Like other species, Forney and Barlow (1998) found Pacific white-sided dolphins may occasionally shift their distribution in response to changes in oceanographic conditions. Based on passive acoustic monitoring recordings, Pacific white-sided dolphins are the most commonly detected odontocete off Washington, present for 9–10 months each year (Klinck et al., 2015; Oleson & Hildebrand, 2012; Širović et al., 2012a). Aerial surveys conducted in waters off Washington, Oregon, and Northern California in the spring, summer, and fall of 2011 and 2012 found Pacific white-sided dolphins present in all three survey seasons. They were the second-most frequently sighted species, and the sightings included two encounters with large pods estimated to number 955 individuals (Adams et al., 2014). Based on habitat models derived from line-transect survey data collected between 1991 and 2009 off the U.S. West Coast, Pacific white-sided dolphins are distributed throughout the Offshore portion of the Study Area during the summer and fall (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2016; Forney et al., 2012). In the NMFS 2014 survey of the U.S. West Coast, sightings of Pacific white-sided dolphins were very low in Southern and Central California, indicative of a distributional shift to the north in comparison to their previous distribution found during the three surveys undertaken between 2001 and 2008 (Barlow, 2016).

Offshore. For the Offshore portion of the Study Area and as input for the acoustic effects modeling, the Navy assumes Pacific white-sided dolphins may be present year round, with increased abundance in the summer and fall seasons.

Inland Waters. With the exception of reported opportunistic sightings of the species the Strait of Juan de Fuca and the waters around the San Juan Islands, there have been very few sightings in the Inland Waters area in the last decade, and none were detected during aerial surveys of Puget Sound between 2013 and 2016 (Smultea et al., 2017; U.S. Department of the Navy, 2017h). Pacific white-sided dolphin occurrence in the Inland Waters is considered rare with the exception of southern Puget Sound, where occurrence is considered extralimital.

Western Behm Canal, Alaska. Based on survey data from Southeast Alaska (Dahlheim et al., 2009), Pacific white-sided dolphins may occur within the Behm Canal portion of the Study Area.

3.4.1.19 Risso's Dolphin (*Grampus griseus*)

3.4.1.19.1 Status and Management

Risso's dolphins are not considered a threatened or endangered species under the ESA and are not considered depleted under the MMPA. Risso's dolphins in the Offshore and Inland Waters portions of the Study Area are from the California, Oregon, Washington stock (Carretta et al., 2019c; Carretta et al., 2017c).

3.4.1.19.2 Abundance

For the Offshore portion of the Study Area and based on surveys from 1996 to 2014, the abundance of Risso's dolphins in the area (the combined Oregon/Washington stratum and the Northern California stratum) is estimated at 4,906 animals (Barlow, 2016).

3.4.1.19.3 Distribution

Risso's dolphins are not present in Alaska waters. In the Pacific off the U.S. West Coast, Risso's dolphins are found along the continental slope, over the outer continental shelf (Baumgartner, 1997; Cañadas et al., 2002; Cetacean and Turtle Assessment Program, 1982; Davis et al., 1998; Green et al., 1992; Kruse et al., 1999; Mignucci-Giannoni, 1998), and over submarine canyons (Mussi et al., 2004). Surveys off southern Washington, Oregon, and Northern California in the spring, summer, and fall of 2011 and 2012 found Risso's dolphins mostly at the outer-shelf and slope domains between the 200 m and 2,000 m depth stratum (Adams et al., 2014), which was consistent with the distribution of vocalizing Risso's dolphins detected during acoustic monitoring during the same approximate timeframe (Klinck et al., 2015). Based on habitat models derived from line-transect survey data collected between 1991 and 2009 off the U.S. West Coast, relatively high densities of Risso's dolphin are predicted in the Offshore portion of the Study Area during the summer and fall (Barlow et al., 2009; Becker et al., 2020; Becker et al., 2010; Becker et al., 2016; Forney et al., 2012).

Offshore. In surveys of waters within the Offshore portion of the Study Area between 2011 and 2014, Risso's dolphins were found to be fewer in number than Dall's porpoises, but tended to occur in large pods with a mean group size of approximately 17 (Barlow, 2016), and maximum group sizes occasionally exceeding 100 individuals (Adams et al., 2014). Risso's dolphins are expected to be present in the area year round.

Inland Waters. This species is not expected to regularly occur within the Inland Waters portion of the Study Area. There has been only one stranding of the species in the inland waters since 2000 (March 2015 at Samish Bay) and this involved a single individual (National Marine Fisheries Service, 2017a). There were reported sightings of a pair of Risso's dolphins in Puget Sound from the winter of 2011 (Cascadia Research Collective, 2011b) off and on through 2013 (U.S. Department of the Navy, 2017h). Aerial surveys in Puget Sound reported two sightings of a pair of Risso's dolphins in 2013 but none were seen during surveys in 2014, 2015, and 2016 (Smultea et al., 2017) and there were no reports of sightings subsequent to 2013 (U.S. Department of the Navy, 2017h). As a result of these findings, Risso's dolphins are considered rare in the Inland Waters portion of the Study Area.

Western Behm Canal, Alaska. Risso's dolphins are not expected to occur within the Behm Canal portion of the Study Area given there is no indication that they inhabit the area (Dahlheim et al., 2009; Muto et al., 2017; Muto et al., 2018b) and are considered extralimital in this region.

3.4.1.20 Short-Beaked Common Dolphin (*Delphinus delphis*)

3.4.1.20.1 Status and Management

Short-beaked common dolphins are not considered a threatened or endangered species under the ESA and are not considered depleted under the MMPA. Short-beaked common dolphins in the Offshore and Inland Waters portions of the Study Area are from the California, Oregon, Washington stock (Carretta et al., 2019c; Carretta et al., 2017c).

3.4.1.20.2 Abundance

For the Offshore portion of the Study Area and based on surveys from 1996 to 2014, the abundance for short-beaked common dolphins in the area (the combined Oregon/Washington stratum and the Northern California stratum) is estimated at 137,381 animals (Barlow, 2016). Over the period of the surveys, there has been a nearly monotonic increase in abundance of short-beaked common dolphins along the U.S. West Coast (Barlow, 2016).

3.4.1.20.3 Distribution

Short-beaked common dolphins are not present in Alaska waters. Short-beaked common dolphins are mostly a warm temperate to tropical species having densities that are greatest when waters are warmest (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2016; Becker et al., 2014; Forney & Barlow, 1998; Forney et al., 2012). Shifts in distribution are pronounced with seasonal and year-to-year changes in oceanographic conditions; movements may be north-south or inshore-offshore (Barlow et al., 2009; Becker et al., 2016; Becker et al., 2014; Forney & Barlow, 1998; Forney et al., 2012; Henderson et al., 2014a). Short-beaked common dolphin have been encountered in the Offshore portion of the Study Area occasionally as far north as approximately the Washington/Canada border (Adams et al., 2014; Barlow, 2016; Forney, 2007; Hamilton et al., 2009). However, based on habitat models derived from line-transect survey data collected between 1991 and 2009 off the U.S. West Coast, very low densities of short-beaked common dolphins are predicted in the Offshore portion of the Study Area during the summer and fall (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2016; Forney et al., 2012).

Offshore. In aerial surveys conducted in waters off southern Washington, Oregon, and Northern California covering the approximate nearshore half of the Study Area in the spring, summer, and fall of 2011 and 2012, there was only one sighting of short-beaked common dolphins in nearshore waters off Northern California (Adams et al., 2014). During the NMFS 2014 survey, there were no short-beaked common dolphins sighted north of central Oregon (approximately 44° N), and all of those sightings were in the deep ocean beyond the continental shelf (Barlow, 2016). For purposes of the analysis in this Supplemental, short-beaked common dolphins are considered to have a regular presence in the Offshore portion of the Study Area.

Inland Waters. This species is not expected to regularly occur within the Inland Waters portion of the Study Area. A sighting of a pair of short-beaked common dolphins in Puget Sound in 2003 (U.S. Department of the Navy, 2017h) is the only record of this species in the Inland Waters portion of the Study Area. Given the normal distribution of the species and the sightings record, short-beaked common dolphins are considered rare in the Inland Waters of the Study Area.

Western Behm Canal, Alaska. Short-beaked common dolphins are not expected to occur within the Behm Canal portion of the Study Area given there is no indication that they inhabit the area (Dahlheim et al., 2009; Muto et al., 2017; Muto et al., 2019a) and are considered extralimital in this region.

3.4.1.21 Short-Finned Pilot Whale (*Globicephala macrorhynchus*)

3.4.1.21.1 Status and Management

Short-finned pilot whales are not considered a threatened or endangered species under the ESA and are not considered depleted under the MMPA. Short-finned pilot whales in the Offshore and Inland Waters portions of the Study Area are from the California, Oregon, Washington stock (Carretta et al., 2019c; Carretta et al., 2018b).

3.4.1.21.2 Abundance

For the Offshore portion of the Study Area and based on surveys from 1996 to 2014, the abundance for short-finned pilot whales in the area (the combined Oregon/Washington stratum and the Northern California stratum) is estimated at 224 animals (Barlow, 2016).

3.4.1.21.3 Distribution

The short-finned pilot whale is widely distributed throughout most tropical and warm temperate waters of the world coinciding with the abundance of squid, their preferred prey (Bernard & Reilly, 1999; Hui, 1985; Payne & Heinemann, 1993). Pilot whales are typically distributed along the continental shelf break and movements over the continental shelf are common based on observations made off the northeastern United States (Payne & Heinemann, 1993). Short-finned pilot whales are not expected to be present in Alaskan waters based on their preference for warm water areas.

Offshore. During systematic ship surveys conducted between 1996 and 2014, short-finned pilot whales were detected in the Offshore portion of the Study Area once off southern Washington (Hamilton et al., 2009) and once off Northern California during the 2014 survey (Barlow, 2016). In aerial surveys conducted in waters off Washington, Oregon, and Northern California covering the approximate nearshore half of the Study Area in the spring, summer, and fall of 2011 and 2012, short-finned pilot whales were encountered once in a pod of eight individuals off Northern California (Adams et al., 2014). Between 2000 and 2016, there are records of one stranded individual in 2002 on the Oregon's Pacific coast, and one off Washington in 2007 (National Marine Fisheries Service, 2017a). For purposes of the analysis in this Supplemental, short-finned pilot whales are considered to have a regular presence in the Offshore portion of the Study Area.

Inland Waters. This species is not expected to regularly occur within the Inland Waters portion of the Study Area. There have been occasional sightings with unconfirmed and low confidence within Puget Sound attributed to possible short-finned pilot whales (U.S. Department of the Navy, 2017h). Given the normal distribution of the species and the record of sightings, short-finned pilot whales are considered rare in the Inland Waters of the Study Area.

Western Behm Canal, Alaska. Short-finned pilot whales are not expected to occur within the Behm Canal portion of the Study Area given there is no indication that they inhabit the area (Dahlheim et al., 2009; Muto et al., 2017; Muto et al., 2019a) and are considered extralimital in that region.

3.4.1.22 Striped Dolphin (*Stenella coeruleoalba*)

3.4.1.22.1 Status and Management

Striped dolphins are not considered a threatened or endangered species under the ESA and are not considered depleted under the MMPA. Striped dolphins in the Offshore portion of the Study Area are from the California, Oregon, Washington stock (Carretta et al., 2019c; Carretta et al., 2018b; Carretta et al., 2017c).

3.4.1.22.2 Abundance

For the Offshore portion of the Study Area and based on surveys from 1996 to 2014, the abundance of striped dolphins in the area (the combined Oregon/Washington stratum and the Northern California stratum) is estimated at 8,335 animals (Barlow, 2016).

3.4.1.22.3 Distribution

Although primarily a warm-water species, the range of the striped dolphin extends higher into temperate regions than those of any other species in the genus *Stenella*. Striped dolphins are generally restricted to oceanic regions and are seen close to shore only where deep water approaches the coast. Along the west coast of North America, southern Washington State is the known northern limit of the species (Barlow, 2016; Hamilton et al., 2009; Reeves et al., 2002b). Striped dolphins are not present as far north as Alaska waters. Based on habitat models derived from line-transect survey data collected between 1991 and 2009 off the U.S. West Coast, extremely low densities of striped dolphins are predicted well offshore in the Study Area during the summer and fall (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2016; Forney et al., 2012).

Offshore. NMFS summer surveys between 1996 and 2014 only detected striped dolphins off the coast of southern Washington State and waters to the south, generally in the deep ocean beyond approximately 100 NM from shore (Barlow, 2016; Hamilton et al., 2009). Striped dolphins were not identified in aerial surveys conducted in waters inside the 2,000 m isobath off southern Washington, Oregon, and Northern California in the spring, summer, and fall of 2011 and 2012 (Adams et al., 2014), which is expected given their general offshore distribution.

Inland Waters. This species is not expected to occur within the Inland Waters portion of the Study Area. Given the normal distribution of the species, striped dolphins are considered extralimital in the Inland Waters portion of the Study Area.

Western Behm Canal, Alaska. Striped dolphins are not expected to occur within the Behm Canal portion of the Study Area given there is no indication that they inhabit the area (Dahlheim et al., 2009; Muto et al., 2017; Muto et al., 2019a) and are considered extralimital in this region.

3.4.1.23 Dwarf Sperm Whale (*Kogia sima*)

3.4.1.23.1 Status and Management

Dwarf sperm whales are not considered a threatened or endangered species under the ESA and are not considered depleted under the MMPA. Dwarf sperm whales in the Offshore portion of the Study Area are from the California, Oregon, Washington stock (Carretta et al., 2019c; Carretta et al., 2017c). Along the U.S. West Coast and because of the difficulty distinguishing between dwarf and pygmy sperm whales at sea, identifications during surveys have generally been to *Kogia* spp. as the lowest taxonomic level of identification possible (Barlow, 2016; Carretta et al., 2017c; Hamilton et al., 2009). As a result, metrics for the population in the stock assessments for U.S. West Coast have been to *Kogia* spp. (Carretta et al., 2019c; Carretta et al., 2017c).

3.4.1.23.2 Abundance

For the Offshore portion of the Study Area and based on surveys from 1996 to 2014, the abundance for *Kogia* spp. in the area (the combined Oregon/Washington stratum and the Northern California stratum) is estimated at 766 animals (Barlow, 2016).

3.4.1.23.3 Distribution

There has only been one sighting identified as *Kogia* spp. north of California on any of the survey efforts between 1991 and 2014 (Barlow, 2016; Hamilton et al., 2009). Along the U.S. West Coast, no reported sightings of this species have been confirmed as dwarf sperm whales, and it is likely that most Kogia species off California are pygmy sperm whale (*Kogia breviceps*) (Carretta et al., 2019c; Carretta et al., 2017c). There is record of a single dwarf sperm whale stranding at Vancouver Island British Columbia (Willis & Baird, 1998b) and one stranded unidentified *Kogia* spp. in Washington in 2007 (National Marine Fisheries Service, 2017a).

Offshore. Dwarf sperm whales are expected to be rare in the Offshore portion of the Study Area.

Inland Waters. Dwarf sperm whales are not expected to occur within the Inland Waters portion of the Study Area.

Western Behm Canal, Alaska. Dwarf sperm whales are not expected to occur within the Behm Canal portion of the Study Area.

3.4.1.24 Pygmy Sperm Whale (*Kogia breviceps*)

3.4.1.24.1 Status and Management

Pygmy sperm whales are not considered a threatened or endangered species under the ESA and are not considered depleted under the MMPA. Pygmy sperm whales in the Offshore portion of the Study Area are from the California, Oregon, Washington stock (Carretta et al., 2019c; Carretta et al., 2017c). Along the U.S. West Coast and because of the difficulty distinguishing between pygmy and dwarf sperm whales at sea, identifications during surveys have generally been to *Kogia* spp. as the lowest taxonomic level of identification possible (Barlow, 2016; Carretta et al., 2017c; Hamilton et al., 2009). As a result, metrics for the population in the SAR for U.S. West Coast are for *Kogia* spp. (Carretta et al., 2019c; Carretta et al., 2017c).

3.4.1.24.2 Abundance

For the Offshore portion of the Study Area and based on surveys from 1996 to 2014, the abundance for *Kogia* spp. in the area (the combined Oregon/Washington stratum and the Northern California stratum) is estimated at 766 animals (Barlow, 2016).

3.4.1.24.3 Distribution

There has only been one sighting identified as *Kogia* spp. north of California on any of the survey efforts between 1991 and 2014 (Barlow, 2016; Hamilton et al., 2009). It has been suggested that most of the sightings identified as *Kogia* spp. were probably pygmy sperm whales (Carretta et al., 2017c). The presence of pygmy sperm whales in the Study Area is also suggested by the occurrence of three strandings confirmed as pygmy sperm whale (one individual in Oregon in 2006 and 2016; one in Washington in 2005) and one stranded unidentified *Kogia* spp. Washington in 2007 (National Marine Fisheries Service, 2017a).

Offshore. Pygmy sperm whales are expected to be present year round in the Offshore portion of the Study Area.

Inland Waters. Pygmy sperm whales are not expected to occur within the Inland Waters portion of the Study Area.

Western Behm Canal, Alaska. Pygmy sperm whales are not expected to occur within the Behm Canal portion of the Study Area.

3.4.1.25 Dall's Porpoise (*Phocoenoides dalli*)

3.4.1.25.1 Status and Management

Dall's porpoise are not considered a threatened or endangered species under the ESA and neither stock in the Study Area is considered depleted under the MMPA. Dall's porpoise in the Behm Canal portion of the Study Area are from the Alaska stock (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a), and those in the Offshore and Inland Waters portion are from the California, Oregon, Washington stock (Carretta et al., 2019c; Carretta et al., 2017c).

3.4.1.25.2 Abundance

There are no reliable abundance data for the Alaska stock of Dall's porpoise given the most recent data are over 26 years old (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). The current estimate of abundance provided in the Alaska SAR is 83,400 animals (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). The most recently reported data from surveys in Southeast Alaska is from 2012, but this did not include Behm Canal (Jefferson et al., 2019).

For the Offshore and Inland Waters portion of the Study Area and based on surveys from 1991 to 2014, the abundance for Dall's porpoise in the area (the combined Oregon/Washington stratum and the Northern California stratum) is estimated at 33,073 animals (Barlow, 2016). The most recent NMFS survey in 2014 found Dall's porpoise abundance fairly typical of their abundance in the previous three surveys between 2001 and 2008 (Barlow, 2016).

3.4.1.25.3 Distribution

Dall's porpoise is one of the most abundant small cetaceans in the North Pacific Ocean along the outer continental shelf, slope, and oceanic waters where water temperatures are less than 17°C (Barlow, 2016; Becker et al., 2017; Carretta et al., 2017c; Ford et al., 2010; Houck & Jefferson, 1999; Jefferson et al., 2015; Reeves et al., 2002b; Suzuki et al., 2016). In the eastern north Pacific, the species ranges from Southern California to the Bering Sea. Dall's porpoise distribution off the U.S. West Coast is highly variable between years, most likely due to changes in oceanographic condition, with Dall's porpoise shifting their distribution in response to those changes on both interannual and seasonal time scales (Barlow, 2016; Becker et al., 2010; Becker et al., 2012b; Becker et al., 2017; Carretta et al., 2017c; Forney & Barlow, 1998; Forney et al., 2015; Forney et al., 2012). In the NMFS 2014 survey of the U.S. West Coast, sightings of Dall's porpoise were very low in Southern and Central California, indicative of a distributional shift to the north in comparison to their previous distribution found during the three surveys undertaken between 2001 and 2008 (Barlow, 2016).

Offshore. Dall's porpoise have been one of the most frequently sighted marine mammal during surveys in waters off Washington, Oregon, and Northern California (Adams et al., 2014; Barlow, 2016; Hamilton et al., 2009; Oleson et al., 2009). In the spring, summer, and fall of 2011 and 2012, Dall's porpoise were most often encountered between the 200 and 2,000 m depth isobaths (Adams et al., 2014). For purposes of the analysis in this Supplemental, Dall's porpoise are considered to have a regular presence in the Offshore portion of the Study Area.

Inland Waters. Dall's porpoise used to be present in the inland waters year round with seasonably variable but relatively high estimated abundance (Calambokidis & Baird, 1994). In recent years, Dall's porpoise have been declining in number in the Salish Sea and Puget Sound, and speculation has been that this decline is a result of competition with harbor porpoise, which have dramatically increased in numbers over approximately the last 15 years (Evenson et al., 2016; Jefferson et al., 2016; Smultea et al., 2017). Consistent with this decline, in six aerial surveys of Puget Sound between 2013 and 2016, only a single Dall's porpoise was observed in Hood Canal in April 2015, and a group of eight was observed in Admiralty Inlet in January 2016 (Smultea et al., 2017). Although they have been seen in decreasing numbers in recent years, for purposes of the analysis in this Supplemental, Dall's porpoise are considered to have a regular presence in the Inland Waters portion of the Study Area.

Western Behm Canal, Alaska. Dall's porpoise was the most frequently observed species during surveys conducted in the inland waters of southeast Alaska between 1991 and 2012 (Dahlheim et al., 2009; Jefferson et al., 2019). Dall's porpoise is a common inhabitant of these waters from at least spring to early fall with the peak abundance occurring in the spring (Jefferson et al., 2019). Although surveys have not been conducted in the winter months in southeast Alaska, it is possible that Dall's porpoises may be present in the winter season; for purposes of this analysis, the Navy assumes the species is present year round.

3.4.1.26 Harbor Porpoise (*Phocoena phocoena*)

3.4.1.26.1 Status and Management

Harbor porpoise are not considered a threatened or endangered species under the ESA. Harbor porpoise in the Behm Canal portion of the Study Area belong to the Southeast Alaska stock, which spans an area of approximately 500 NM in length from Dixon Entrance in the south to Cape Suckling in the north (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). Studies of harbor porpoise distribution elsewhere have indicated that this stock structure is likely more fine-scaled than is reflected in the current Alaska SAR but no data are available to more precisely define the stock structure for harbor porpoise in Alaska (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). In the Offshore portion of the Study Area, there are two stocks consisting of the Northern Oregon/Washington Coast stock and the Northern California/Southern Oregon stock (Carretta et al., 2019c; Carretta et al., 2017c). In the Inland Waters portion of the Study Area harbor porpoise belong to the Washington Inland Waters stock (Carretta et al., 2019c; Carretta et al., 2017c). None of the stocks of harbor porpoise in the Study Area are considered depleted under the MMPA.

3.4.1.26.2 Abundance

In surveys conducted over approximately 20 years in Southeast Alaska, the overall abundance of harbor porpoise in the Ketchikan region (including Behm Canal) significantly declined from the early 1990s to the mid-2000s, followed by a significant increase in the early 2010s when abundance rose to levels similar to those observed 20 years earlier (Dahlheim et al., 2015). It is not clear whether the observed decline and subsequent increase in abundance noted in the Ketchikan region was a true change in the stock abundance or if the decline and subsequent increase reflected the redistribution of local harbor porpoise to and from other areas in response to local fluctuations in prey availability, habitat suitability, or other unidentified factors (Dahlheim et al., 2015; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). The Alaska SAR divides the estimates of abundance for the Southeast Alaska stock of harbor porpoise into a northern and a southern region including Frederick Sound, Sumner Strait, Wrangell and Zarembo Islands, and Clarence Strait as far south as Ketchikan, with an abundance of 577 animals in that southern region (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a).

In the Offshore portion of the Study Area, the abundance of the Northern Oregon/Washington Coast stock is 21,487 and the Northern California/Southern Oregon stock is 24,195 (Carretta et al., 2019c; Carretta et al., 2017c). In the Inland Waters portion of the Study Area the abundance of the Washington Inland Waters stock is 11,233 (Carretta et al., 2019c; Carretta et al., 2017c). Evenson et al. (2016) determined that the annual growth rate for harbor porpoise between 1995 and 2014 was 8.1 percent for the Strait of Juan de Fuca region and the annual growth rate between 2000 and 2014 was

36.9 percent for Puget Sound[6]. Along with other findings (Huggins et al., 2015), aerial surveys between 2013 and 2015 have demonstrated that since the 1970s, harbor porpoises have recovered and reoccupied waters of Puget Sound (Jefferson et al., 2016).

3.4.1.26.3 Distribution

In the eastern North Pacific from Alaska south to Point Conception, California, harbor porpoise are found in nearshore coastal and inland waters, generally within a mile or two of shore (Barlow, 1988; Carretta et al., 2015; Carretta et al., 2017c; Dahlheim et al., 2015; Dohl et al., 1983; Hamilton et al., 2009; Holdman et al., 2019; Muto et al., 2017; Muto et al., 2018b). As noted previously, there is evidence for the redistribution of local harbor porpoise to and from other areas in response to what are likely local fluctuations in prey availability, habitat suitability, or other unidentified factors (Dahlheim et al., 2015; Evenson et al., 2016; Holdman et al., 2019; Jefferson et al., 2016; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a; Smultea et al., 2015; Smultea et al., 2017; Wisniewska et al., 2018).

Offshore. In aerial surveys conducted in waters off Washington, Oregon, and Northern California covering the approximate nearshore half of the Study Area in the spring, summer, and fall of 2011 and 2012, harbor porpoise were the most frequently sighted marine mammal (Adams et al., 2014). Off Oregon and consistent with their expected distribution, acoustic data collected over six months in 2014 documented a daily pattern of harbor porpoise foraging and habitat use related to tidal and diel forcing at two shallow (>80 m) nearshore sites (Holdman et al., 2019). Harbor porpoise are expected to be present in the Offshore portion of the Study Area year round.

Inland Waters. Based on surveys in the Salish Sea and Puget Sound (Elliser et al., 2017; Evenson et al., 2016; Jefferson et al., 2016; Smultea et al., 2017), harbor porpoise are expected to be present in the Inland Waters portion of the Study Area year round. Calves are more likely to be seen in fall, which surveys off Fidalgo Island from January 2014 to February 2017 indicated was also when the highest number of sightings per unit of survey effort were present (Elliser et al., 2017).

Western Behm Canal, Alaska. Although surveys have not occurred in Southeast Alaska in the winter (Dahlheim et al., 2009; Dahlheim et al., 2015), for purposes of this analysis the Navy assumes harbor porpoise will be present in the Behm Canal portion of the Study Area year round.

3.4.1.27 Sperm Whale (*Physeter macrocephalus*)

3.4.1.27.1 Status and Management

Sperm whales are listed as endangered under the ESA, but there is no designated critical habitat for this species. Sperm whales in Alaska are from the North Pacific stock (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a) but are not expected to be present in the Behm Canal portion of the Study Area. Sperm Whales in the Offshore portion of the Study Area are from the California, Oregon, Washington

[6] As an update to the information presented in the 2015 NWTT Final EIS/OEIS, Section 3.4.3.1.8 (Stranding) (_ENREF_1339) with regard to the 2006 Unusual Mortality Event for harbor porpoise that NMFS had declared in the Pacific Northwest, it is now known that the reported strandings were unrelated to any actual unusual mortality event. What had been characterized as an increase in harbor porpoise stranding starting in the Spring of 2003 (_ENREF_1018), was the result of, "… a combination of factors that have been identified as including: (1) a growing population of harbor porpoises; (2) expansion of harbor porpoises into previously sparsely populated areas in Washington's inland waters; and (3) a more well established stranding network that resulted in better reporting and response" (_ENREF_599).

stock (Carretta et al., 2019c; Carretta et al., 2018b; Carretta et al., 2017c). Both of these stocks of sperm whales are considered depleted under the MMPA.

3.4.1.27.2 Abundance

For the Offshore portion of the Study Area and based on surveys from 1996 to 2014, the abundance for sperm whales in the area (the combined Oregon/Washington stratum and the Northern California stratum) is estimated at 1,997 (Carretta et al., 2019c). Moore and Barlow (2017) have noted there is little evidence of trends in overall sperm whale abundance for the stock present in the NWTT Study Area, but that new analysis of the available data supports prior evidence for an increasing number of sperm whales that occur in small groups.

3.4.1.27.3 Distribution

Sperm whales are typically found in temperate and tropical waters with a broad distribution across the North Pacific (Merkens et al., 2019; Rice, 1989). The secondary range includes the areas of higher latitudes in the northern Pacific including Alaska (Jefferson et al., 2015; Whitehead et al., 2008; Whitehead & Weilgart, 2000; Whitehead et al., 2009). This species appears to have a preference for deep waters (Baird, 2013; Becker et al., 2012a; Becker et al., 2010; Forney et al., 2012; Jefferson et al., 2015). Typically, sperm whale concentrations correlate with areas of high productivity. These areas are generally near drop offs and areas with strong currents and steep topography (Gannier & Praca, 2007; Jefferson et al., 2015); the semi-permanent the Strait of Juan de Fuca eddy is one such area (see MacFadyen et al. (2008)). Sperm whales are somewhat migratory as demonstrated by discovery tag data and subsequent satellite tag locational data; three sperm whales satellite-tagged off southeastern Alaska were documented moving far south to waters off Mexico and the Mexico/Guatemala border (Straley et al., 2014).

Offshore. No sperm whales were detected during systematic surveys of waters between the British Columbia border with Alaska and Washington (Williams & Thomas, 2007). In aerial surveys conducted in waters off Washington, Oregon, and Northern California covering the approximate nearshore half of the Study Area in the spring, summer, and fall of 2011 and 2012, sperm whales were encountered only twice, in deep water off the coast from Grays Harbor (Adams et al., 2014). During the NMFS 2014 summer shipboard survey in the Study Area, there were a total of five sperm whale sightings (Barlow, 2016). The variable presence of sperm whales in the area is reflected in the acoustic monitoring record of sperm whale click detections. In 2008, sperm whales were present in the acoustic record between April through November and in the following year from February through May (Oleson & Hildebrand, 2012). In similar acoustic monitoring efforts between 2010 to 2013, sperm whales were found to be present from November through June (Debich et al., 2014; Kerosky et al., 2013; Klinck et al., 2015; Širović et al., 2012a). For purposes of the analysis in this Supplemental, sperm whales are considered to have a regular presence in the Offshore portion of the Study Area.

Inland Waters. This species is not expected to occur within the Inland Waters portion of the Study Area. Given the normal distribution of sperm whales in deep water ocean areas, they are considered extralimital in the Inland Waters of the Study Area.

Western Behm Canal, Alaska. Sperm whales are not expected to occur within the Behm Canal portion of the Study Area given there is no indication that they inhabit the area (Dahlheim et al., 2009; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a) and are considered extralimital in this region.

3.4.1.28 Baird's Beaked Whale (*Berardius bairdii*)

3.4.1.28.1 Status and Management

Baird's beaked whale is not listed under the ESA. Baird's beaked whale is managed by NMFS within Pacific U.S. EEZ waters as two stocks: (1) an Alaska stock; and (2) a California, Oregon, and Washington stock, and these stocks are not considered depleted under the MMPA (Carretta et al., 2019c; Carretta et al., 2018b; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a).

3.4.1.28.2 Abundance

There is currently no reliable abundance estimate for the Alaska stock of Baird's beaked whale (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a), which the Navy has assumed will not be present in Behm Canal. For the Offshore portion of the Study Area and based on surveys from 1991 to 2014, the abundance for Baird's beaked whales in the area (the combined Oregon/Washington stratum and the Northern California stratum) is estimated at 4,326 animals (Barlow, 2016).

3.4.1.28.3 Distribution

This species is generally found through the colder waters of the North Pacific north of 28°N ranging from waters off Baja California, Mexico, to the Aleutian Islands of Alaska (Jefferson et al., 2015; Kasuya & Miyashita, 1997; MacLeod et al., 2006; Reeves et al., 2002b). Within their range, Baird's beaked whale 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., 2015; Kasuya, 2009). Off Washington and British Columbia, Baird's beaked whales have been sighted in offshore waters with bottom depths of 700 m to 1,675 m (Willis & Baird, 1998a). Based on habitat models derived from line-transect survey data collected between 1991 and 2008 off the U.S. West Coast, encounters with Baird's beaked whales increase near the 2,000 m isobath and further offshore in waters off Washington and Oregon (Barlow, 2016; Becker et al., 2012b). Satellite location data from an individual Baird's beaked whale recently tagged off of Southern California indicated that, over a period of 6.5 days, the individual traveled north along the continental shelf-edge more than 740 km from the initial tagging location while making dives as deep as 1,968 m and lasting as long as 78 minutes (Schorr et. al., Unpublished). This seemingly routine long-distance movement is consistent with research findings from Cuvier's beaked whales documented in previous research (Schorr et al., 2008; Schorr et al., 2014).

Offshore. NMFS surveys have consistently revealed that abundance estimates were highest off Oregon and Washington as compared to areas off California (Barlow, 2003, 2010, 2016).

Acoustic analyses of data collected from Navy-funded monitoring devices in Washington offshore waters have routinely detected Baird's beaked whale vocalizations (Debich et al., 2014; Kerosky et al., 2013; Širović et al., 2012a; Trickey et al., 2015). There has, however, been variability for the timing of these detections; they occurred between January and November 2011, with a peak in detections in February and July (Širović et al., 2012b), from October through December 2012, with a peak in detections in May 2013 (Debich et al., 2014; Kerosky et al., 2013), and from August 2013 through January 2014, with an additional single encounter in March 2014 (Trickey et al., 2015). During aerial surveys conducted in waters off Washington, Oregon, and Northern California covering the approximate nearshore half of the Study Area in the spring, summer, and fall of 2011 and 2012, there was a sighting of a Baird's beaked whale group consisting of 10 individuals (Adams et al., 2014), and five group sightings during the 2014 NMFS survey with the same approximate average group size (Barlow, 2016). For purposes of the analysis in this Supplemental, Baird's beaked whales are considered to have a regular presence in the Offshore portion of the Study Area.

Inland Waters. Given their offshore distribution, Baird's beaked whales are not expected to occur within the Inland Waters portion of the Study Area.

Western Behm Canal, Alaska. In the North Pacific Ocean and along the U.S. West Coast, Baird's beaked whales are seen primarily along the continental slope in deep waters (Barlow, 2016; Rone et al., 2017). Baird's beaked whales have been sighted in the Gulf of Alaska (Rone et al., 2017) and off the Pacific coast of Southeast Alaska (Hamilton et al., 2009), but were not observed during the 1991–2007 surveys of the inland waters of southeast Alaska (Dahlheim et al., 2009). There is no indication that beaked whales inhabit the Behm Canal portion of the Study Area (Dahlheim et al., 2009; Muto et al., 2017; Muto et al., 2018b), and they are considered extralimital in this location.

3.4.1.29 Cuvier's Beaked Whale (*Ziphius cavirostris*)

3.4.1.29.1 Status and Management

Cuvier's beaked whales are not considered a threatened or endangered species under the ESA, and neither of these stocks in the Study Area is considered depleted under the MMPA. Cuvier's beaked whale is managed by NMFS within Pacific U.S. EEZ waters as two stocks: (1) the Alaska stock (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a); and (2) the California, Oregon, Washington stock (Carretta et al., 2019c; Carretta et al., 2018b; Carretta et al., 2017c).

3.4.1.29.2 Abundance

There is currently no reliable abundance estimate for the Alaska stock of Cuvier's beaked whale (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a), which Navy assumes will not be present in Behm Canal for purposes of the acoustic effects modeling.

For the Offshore portion of the Study Area and based on surveys from 1991 to 2014, the abundance for Cuvier's beaked whales in the area (the combined Oregon/Washington stratum and the Northern California stratum) is estimated at 1,442 animals (Barlow, 2016).

3.4.1.29.3 Distribution

Cuvier's beaked whales have an extensive range that includes all oceans, from the tropics to the polar waters of both hemispheres (Baird et al., 2010; Heyning & Mead, 2009; Jefferson et al., 2015; MacLeod et al., 2006; Schorr et al., 2014). Worldwide, beaked whales normally inhabit both slope and deep oceanic waters with depths greater than 200 m and frequently where depths are greater than 1,000 m (Baird et al., 2010; Jefferson et al., 2015; MacLeod et al., 2006; MacLeod & D'Amico, 2006; MacLeod et al., 2003; Schorr et al., 2014). Research findings for satellite location tagged Cuvier's beaked whales in the Southern California Range Complex (Falcone & Schorr, 2011, 2012, 2013, 2014; Falcone et al., 2009), which is the same stock of animals present in the NWTT Study Area, have documented movements by individuals in excess of hundreds of kilometers. Schorr et al. (2014) reported that five out of eight tagged whales journeyed approximately 250 km from their tag deployment location, and one of these individuals made an excursion of over 450 km to the south of its initial location and then back.

Offshore. Cuvier's beaked whales have been routinely sighted during NMFS surveys in the waters of the Study Area (Barlow, 2016; Hamilton et al., 2009). Offshore of Washington, Cuvier's beaked whales have been acoustically detected in the winter and spring (between mid-November and April (Debich et al., 2015; Kerosky et al., 2013; Trickey et al., 2015)), although they were also detected sporadically in the spring through fall (February–September) in 2011 and 2012 (Kerosky et al., 2013; Širović et al., 2012a). The Navy assumes that, for purposes of the acoustic effects modeling, this is indicative of variable year-round presence in the Offshore portion of the Study Area, consistent with data gathered from other locations (DiMarzio et al., 2018; Moretti, 2017; Schorr et al., 2018).

Inland Waters. Based on the available information (National Marine Fisheries Service, 2017a; U.S. Department of the Navy, 2017h), beaked whales are not expected to occur within the Inland Waters portion of the Study Area.

Western Behm Canal, Alaska. There is no indication that beaked whales inhabit the Behm Canal portion of the Study Area (Dahlheim et al., 2009; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a), and they are considered extralimital in this location.

3.4.1.30 Mesoplodont Beaked Whales (*Mesoplodon spp*.)

3.4.1.30.1 Status and Management

None of the Mesoplodont beaked whales are considered a threatened or endangered species under the ESA, and none of the stocks are considered depleted under the MMPA. Due to the difficulty in distinguishing the different *Mesoplodon* species from one another at sea during surveys, NMFS has defined a single management unit ("Mesoplodont beaked whales") for all *Mesoplodon* stocks that occur along the U.S. West Coast (Carretta et al., 2019c; Carretta et al., 2018b). The stock assigned to that management unit is considered the California, Oregon, Washington stock (Carretta et al., 2019c; Carretta et al., 2018b). The six species in this Mesoplodont beaked whales management unit are Blainville's beaked whale (*M. densirostris*), Hubbs' beaked whale (*M. carlhubbs*i), Perrin's beaked whale (*M. perrini*), pygmy beaked whale (*M. peruvianus*), gingko-toothed beaked whale (*M. gingkodens*), and Stejneger's beaked whale (*M. stejnegeri*). Stejneger's beaked whale is the only species of *Mesoplodon* known to occur in Alaska waters (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). In addition to the California, Oregon, and Washington stock of Mesoplodont beaked whales, the population of Stejneger's beaked whales in Alaska is recognized as the Alaska stock, separately from Stejneger's and other Mesoplodont beaked whales found off California, Oregon, and Washington (Carretta et al., 2019c; Carretta et al., 2018b; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a).

3.4.1.30.2 Abundance

There is currently no reliable abundance estimate for the Alaska stock of Stejneger's beaked whale. With the approximate distribution believed to be well offshore of the Pacific coast of Southeast Alaska (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a), the Navy presumes there will be no Stejneger's or other Mesoplodont beaked whales present in Behm Canal.

For the Offshore portion of the Study Area and based on surveys from 1991 to 2014, the abundance for Mesoplodont beaked whales in the area (the combined Oregon/Washington stratum and the Northern California stratum) is estimated at 1,036 animals (Barlow, 2016).

3.4.1.30.3 Distribution

Worldwide, beaked whales normally inhabit both slope and deep oceanic waters with depths greater than 200 m and frequently where depths are greater than 1,000 m (Baird et al., 2010; Jefferson et al., 2015; MacLeod et al., 2006; MacLeod & D'Amico, 2006; MacLeod et al., 2003; Schorr et al., 2014). As available, relevant species-specific distribution information is summarized below for the six Mesoplodont beaked whales that are included in the NMFS management unit.

Blainville's beaked whale is one of the most widely distributed species within the *Mesoplodon* genus found mostly offshore in deeper waters along the California coast, Hawaii, Fiji, Japan, and Taiwan, as well as throughout the eastern tropical Pacific (Baumann-Pickering et al., 2014; Jefferson et al., 2015; Leslie et al., 2005; MacLeod, 2000; MacLeod & Zuur, 2005; Mahaffy et al., 2015). There was one confirmed sighting of Blainville's beaked whale approximately 150 NM off the coast of Southern Oregon during a NMFS survey (Hamilton et al., 2009). An acoustic monitoring device offshore off Washington detected Blainville's beaked whale pulses once, in March 2011 (Širović et al., 2012b), but none have been detected in similar acoustic monitoring efforts since (Debich et al., 2014; Kerosky et al., 2013; Trickey et al., 2015).

Hubbs' beaked whale distribution is generally associated with the deep subarctic current system along the Pacific coast of North America (Mead, 1989; Mead et al., 1982; Yamada et al., 2012). MacLeod and D'Amico (2006) speculated that the distribution of Hubbs' beaked whale might be continuous across the North Pacific between about 30°N and 45°N, but this remains to be confirmed. There was one sighting of Hubb's beaked whale off the coast of Washington (beyond approximately 300 NM) during a NMFS survey (Hamilton et al., 2009) and there are records of the species having stranded at least seven times in British Columbia (Willis & Baird, 1998a) and once at La Push, Washington (National Marine Fisheries Service, 2017a). The characteristics of its vocalizations are not presently know so the species has not been identified in acoustic monitoring records (Baumann-Pickering et al., 2014).

Perrin's beaked whale distribution generally includes deep waters off the Pacific coast of North America where depths exceed 1,000 m (MacLeod & D'Amico, 2006). Perrin's beaked whale is known only from five stranded specimens along the California coastline south of Monterey from 1975 to 1997, and given the scarcity of data regarding the species, the full extent of Perrin's beaked whale distribution is unknown (Dalebout et al., 2002; MacLeod et al., 2006). The properties of echolocation signals produced by this species are unknown and those thought to possibly be produced by Perrin's beaked whales have not been detected in the Study Area (Baumann-Pickering et al., 2012).

Pygmy beaked whale distribution is based on stranding data from the Pacific coast of Mexico, Peru, and Chile (MacLeod & D'Amico, 2006; Pitman & Lynn, 2001; Sanino et al., 2007) and sightings during NMFS surveys indicate the species appears to be endemic to the eastern tropical Pacific between about 30°N to 30°S (Hamilton et al., 2009; MacLeod & D'Amico, 2006). The properties of echolocation signals produced by this species are unknown, and those thought to possibly be produced by Pygmy beaked whales have not been detected in the Study Area (Baumann-Pickering et al., 2012).

Ginkgo-toothed beaked whale distribution likely includes deep waters off the Pacific coast of North America. The handful of known records of the ginkgo-toothed beaked whale is from strandings, one of which occurred in California (Jefferson et al., 2015; MacLeod & D'Amico, 2006). The properties of echolocation signals produced by this species are unknown, and those thought to possibly be produced by ginkgo-toothed beaked whales have not been detected in the Study Area (Baumann-Pickering et al., 2012).

Stejneger's beaked whale appears to prefer cold temperate and subpolar waters on the steep slope of the continental shelf in water depths ranging from 730 to 1,560 m (Loughlin & Perez, 1985; MacLeod et al., 2006; Mead, 1989). The farthest south this species has been observed in the eastern Pacific is Cardiff, California (33°N); and this was previously considered an extralimital occurrence (Loughlin & Perez, 1985; MacLeod et al., 2006; Mead, 1989), but acoustic monitoring has since and on rare occasions detected vocalizations in Southern California waters, confirming the species' range that far south

(Baumann-Pickering et al., 2012). Stejneger's beaked whales have only been visually detected twice during NMFS surveys, once in the Aleutian Islands and once in the Gulf of Alaska (Hamilton et al., 2009). Stejneger's beaked whales were the most consistently detected beaked whale off Washington between September and June in multiple years of acoustic monitoring effort (Baumann-Pickering et al., 2012; Debich et al., 2014; Kerosky et al., 2013; Širović et al., 2012a; Trickey et al., 2015).

Offshore*.* There were a total of 16 sightings of species identified to the genus *Mesoplodon* based on surveys from 1991 to 2014 for the combined Oregon/Washington stratum and the Northern California stratum (Barlow, 2016), which approximates the Offshore portion of the Study Area. Given these sightings and the consistent acoustic monitoring detections from species in the management unit, Mesoplodont beaked whales are expected to have a regular presence in the Offshore portion of the Study Area.

Inland Waters. Based on the available information (National Marine Fisheries Service, 2017a; U.S. Department of the Navy, 2017h), beaked whales are not expected to occur within the Inland Waters portion of the Study Area.

Western Behm Canal, Alaska. There is no indication that beaked whales inhabit the Behm Canal portion of the Study Area (Dahlheim et al., 2009; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a), and they are considered extralimital in this location.

Pinnipeds

3.4.1.31 California Sea Lion (*Zalophus californianus*)

3.4.1.31.1 Status and Management

The California sea lion is protected under the MMPA and is not listed under the ESA. NMFS has defined one stock for the California sea lion (U.S. stock), with five genetically distinct geographic populations identified: (1) Pacific Temperate, (2) Pacific Subtropical, (3) Southern Gulf of California, (4) Central Gulf of California, and (5) Northern Gulf of California (Carretta et al., 2019c; Carretta et al., 2018a). The Pacific Temperate population is the only population expected in the Study Area and constitutes the U.S. stock. However, movement of sea lions between U.S. waters as far north as the Gulf of Alaska, through Canada, and south as far as Mexican waters off the Baja Peninsula has been documented (Carretta et al., 2019c; Carretta et al., 2018a; DeLong et al., 2017). In addition to rookeries in U.S. waters the Pacific Temperate population includes sea lions from rookeries on the Coronado Islands just south of the U.S.–Mexico border. However, pup production at the Coronado Islands is minimal compared with U.S. rookeries and does not represent a significant contribution to the overall size of the Pacific Temperate population (Carretta et al., 2019c; Carretta et al., 2018a).

3.4.1.31.2 Abundance

The current population estimate of California sea lions in the U.S. stock is 257,606 (Carretta et al., 2019c; Carretta et al., 2018a). The total population in U.S. waters cannot be counted because all age and sex classes are not ashore at the same time during field surveys. In lieu of counting all sea lions, pups are counted during the breeding season (because this is the only age class that is ashore in its entirety), and the number of births is estimated from the pup count. The size of the U.S. population is then estimated from the number of births and the proportion of pups observed at the surveyed rookeries (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017c; Laake et al., 2018).

Abundance in the NWTT Study area was estimated from aerial surveys of California sea lions offshore and at haulout locations in central and Northern California conducted in May–June, September, and

December of 1998 and July 1999 (Lowry & Forney, 2005; Wright et al., 2010). Only data from the Northern California strata were used to estimate abundance in the Study Area. Males are much more likely to migrate into the Oregon and Washington portion of the Study Area than females, but some females are likely to be present in Northern California waters during the non-breeding season, so extrapolating data from Lowry and Forney (2005) is reasonable and is possibly an overestimation of abundance in the Study Area. Abundance in the Study Area is expected to be higher in spring and fall when males are migrating to and from rookeries in Southern California (DeLong et al., 2017; Lowry & Forney, 2005; Wright et al., 2010). The abundances used to estimate sea lion densities in the Study Area ranged from near 0 in summer to over 10,000 in spring. Fall and winter abundances were approximately 7,300 and 8,500, respectively.

3.4.1.31.3 Distribution

California sea lions from the Pacific Temperate population migrate seasonally into the Study Area, and have also been sighted north of the Study Area in Canadian waters (Carretta et al., 2019c; Carretta et al., 2018a; Carretta et al., 2017c). In summer, California sea lions breed on islands extending from the Gulf of California, Mexico to the Channel Islands and depending on oceanographic conditions and prey availability, may travel over 300 km from island rookeries in search of prey (Carretta et al., 2019c; Carretta et al., 2017d; Melin et al., 2008). Their primary rookeries are located in the Channel Islands, specifically San Miguel, San Nicolas, Santa Barbara, and San Clemente islands. Their distribution shifts to the north in fall and to the southeast during winter and spring, probably in response to changes in prey availability (Edgell & Demarchi, 2012). In the non-breeding season, adult and subadult males migrate northward along the coast to central and Northern California, Oregon, Washington, and Vancouver Island, and return south the following spring (DeLong et al., 2017). Individuals are occasionally sighted hundreds of miles offshore (Jeffries et al., 2000; Lowry & Forney, 2005); however, most tend to forage at a maximum of approximately 20–80 NM from shore (DeLong et al., 2017; Lowry & Forney, 2005). Most adult females with pups and juveniles of both sexes remain in waters near their breeding rookeries off the coast of California and Mexico. They also enter bays, harbors, and river mouths and often haul out on human-made structures such as piers, jetties, offshore buoys, and oil platforms. Refer to the Navy's Marine Species Density Database Technical Report for more information on how abundance and distribution information was used to estimate species density (U.S. Department of the Navy, 2017g).

Offshore. California sea lions are the most frequently sighted otariid in Washington waters and use numerous haulout sites along the Pacific coast (DeLong et al., 2017; Jeffries et al., 2000; Lowry & Forney, 2005). In the Study Area, adult females and juvenile animals are rarely present, while males may be present for up to approximately 10 months of each year, returning to rookery islands in Southern California during the pupping and breeding season (May–July) (DeLong & Jeffries, 2017; DeLong et al., 2017; Laake et al., 2018). Sea lions are present along the coast of Oregon from October to April (Lowry et al., 2014). Main haulout sites include the Columbia River (South Jetty), Cascade Head, Cape Arago, and Orford and Rogue Reefs (DeLong & Jeffries, 2017). Sea lions also use the northern coast of California mainly during May and June, and September and October (Lowry & Forney, 2005; Oleson et al., 2009). Main haulout sites include St. George Reef, Castle Rock, and Farallon and Año Nuevo Islands.

California sea lions feed on a wide variety of prey, including many species of fish and squid that are typically found over the continental shelf; the availability of prey drives the distribution of California sea lions. The U.S. Geological Survey conducted seabird and marine mammal surveys off the coasts of Washington, Oregon, and Northern California in winter, summer, and fall from 2011 to 2012 (Adams et al., 2014). California sea lions were the most frequently sighted pinniped species (125 sightings and

213 individuals) and were present year round with slightly more sightings recorded during fall. The number of sightings and relative abundance decreased with distance from shore. California sea lions were most frequently observed over the inner-continental shelf, with 60 percent of sightings and 74 percent of individuals observed at depths less than 100 m (Adams et al., 2014).

Approximately 90 percent of California sea lions are expected to occur within 40 km of shore and all are expected to occur within 70 km of shore (Lowry & Forney, 2005; Oleson et al., 2009; Wright et al., 2010). Males are present in the Offshore Area from November to mid-June when they typically leave the Study Area en route to rookeries in the Channel Islands (DeLong & Jeffries, 2017; Gearin et al., 2017; Wright et al., 2010). Transit time between breeding rookeries and the Study Area is approximately 25 days (Gearin et al., 2017; Wright et al., 2010). Gearin (2017) shows sea lions remain within the 1,000 m isobath during north and south migrations. However, during anomalous conditions (e.g., during an El Nino period) California sea lions may travel farther offshore, presumably seeking prey (Elorriaga-Verplancken et al., 2016b); Weise et al., (2006) reported seeing male California sea lions 450 km from shore, and Melin et al. (2008) reported lactating females traveling more than 300 km from shore on foraging trips.

Inland Waters. Location data from satellite tags on 30 male California sea lions over a two-year period indicated most were transient visitors to the Navy Facilities in Puget Sound (DeLong et al., 2017). As noted above, California sea lions migrate from Puget Sound to rookeries in Southern California in spring and return in fall (DeLong et al., 2017; Gearin et al., 2017; Jeffries, 2014; Jeffries et al., 2000). Adult female and juvenile sea lions are rare in Washington inland waters (DeLong et al., 2017). Transit through Strait of Juan de Fuca is described as rapid (Gearin et al., 2017). The southbound migration between Puget Sound and Southern California rookeries takes approximately 25 days (Gearin et al., 2017); therefore, occurrence of any one individual in the Strait of Juan de Fuca is likely limited to several days in spring and several days in fall. However, not all sea lions would be expected to be in the Strait at the same time.

Seasonal abundance in Puget Sound was estimated to be 788 California sea lions based on counts made at Navy facilities at Bremerton, Bangor, Everett, and Manchester (DeLong et al., 2017). The abundance of California sea lions in the Strait of Juan de Fuca was estimated by assuming all sea lions moved through the Strait of Juan de Fuca in spring (March through May) and fall (September through November) (DeLong & Jeffries, 2017; 2014). Some California sea lions are present year round in Puget Sound (DeLong & Jeffries, 2017; DeLong et al., 2017; Jeffries, 2014). Other established haulout sites are located at Shilshole Bay near Seattle, Commencement Bay and Budd Inlet in southern Puget Sound, and numerous navigation buoys south of Whidbey Island to Olympia (DeLong et al., 2017; Jeffries, 2014; Jeffries et al., 2000). A major winter haulout site is Race Rocks located in Canadian waters of the Strait of Juan de Fuca adjacent to the Study Area (Edgell & Demarchi, 2012) indicating the population is larger and has broader distributions that just within the NWTT Study Area, even when considering only the Inland Waters portion of the NWTT Area.

Western Behm Canal, Alaska. A total of 52 (25 male, 5 female, and 22 undetermined) California sea lions have been reported in Alaskan waters between 1974 and 2004, with an increasing presence in later years (Maniscalco et al., 2004). California sea lions in Alaska most often were seen alone and only occasionally in small groups of two or more, although hundreds have been found to haul out together along the Washington coast and in southern British Columbia. The relatively few California sea lions found in Alaska usually have been associated with Steller sea lions at their haulouts and rookeries. California sea lions are not expected to occur in Behm Canal near SEAFAC.

3.4.1.32 Steller Sea Lion (*Eumetopias jubatus*)

3.4.1.32.1 Status and Management

NMFS has designated two Steller sea lion stocks in the North Pacific corresponding to two DPSs with the same names (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a; Muto et al., 2019b). The Eastern U.S. stock (or DPS) is defined as the population occurring east of 144°W longitude and the Western U.S. stock (or DPS) consists of sea lions occurring west of 144°W longitude. Although the distribution of individuals from the two stocks overlaps outside of the breeding season (DeLong, 2018; Fritz et al., 2016; Hastings et al., 2017; Jemison et al., 2013; Jemison et al., 2018; Raum-Suryan et al., 2004), only sea lions from the Eastern U.S. stock, defined as those living in southeast Alaska, British Columbia, California, and Oregon, are expected in the Study Area (DeLong, 2018; Fritz et al., 2016; Jemison et al., 2013; Raum-Suryan et al., 2004).

The Western U.S. stock is listed as depleted under the MMPA and endangered under the ESA (Muto et al., 2018a; Muto et al., 2018b; Muto et al., 2019a; Muto et al., 2019b). However, Steller sea lions from the Western U.S. stock are not expected to be present in the Study Area, with the exception being the potential negligible presence of a few juvenile males wandering outside the core range area of the stock (DeLong, 2018; Fritz et al., 2016; Jemison et al., 2013; Raum-Suryan et al., 2004). In 1993 (58 FR 45269), areas of critical habitat for the Western DPS were designated by NMFS to include a 20 NM buffer around all major haulouts and rookeries, as well as associated terrestrial, air, and aquatic zones, and three large offshore foraging areas that are all in Alaska waters. None of these designated areas are close (>150 km) to Western Behm Canal, and so analysis of the species critical habitat will not be discussed further in this Supplemental.

The Eastern U.S. stock of Steller sea lions is currently listed as depleted under the MMPA and in recognition of their recovery, Steller sea lions in the Eastern U.S. stock were removed from the List of Endangered and Threatened Wildlife in October 2013 (Muto et al., 2018a; Muto et al., 2018b; Muto et al., 2019a; National Marine Fisheries Service, 2016i).

3.4.1.32.2 Abundance

The Eastern U.S. stock of Steller sea lions has established rookeries and breeding sites along the coasts of California, Oregon, British Columbia, and southeast Alaska. Approximately 30,000 Steller sea lions occur along the coast of British Columbia but those animals are not included in the abundance of sea lions occurring in U.S. waters. In Washington state waters, pups have been observed at multiple breeding sites since 2013, specifically at the Carroll Island and Sea Lion Rock complex and the Tatoosh Island area, and Wiles (2015) estimated that up to 2,500 Steller sea lions are present along the Washington coast. These Steller sea lions in Washington waters are not counted in the stock abundance since that count based only on animals at Alaska rookeries. Based on a 2017 survey, the current estimated abundance is 53,624 Steller sea lions in the Eastern U.S. stock (Muto et al., 2019b). NMFS has estimated that the Eastern stock of Steller sea lions increased at a rate of approximately 4.25 percent per year over the last 40 years (Muto et al., 2019b).

3.4.1.32.3 Distribution

Steller sea lions range along the North Pacific Rim from northern Japan to California, with centers of abundance and distribution in the Gulf of Alaska and Aleutian Islands. The species is not known to migrate, but individuals disperse widely outside of the breeding season (May–July) likely in search of different types of prey (Fritz et al., 2016; Jemison et al., 2013; Jemison et al., 2018; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a; National Marine Fisheries Service, 2013b; Raum-Suryan et al., 2004; Sigler et al., 2017). Males arrive at breeding sites in May with females following shortly afterwards. Pups are born from late May to early July and begin transiting with their mothers to other haulouts at 2–3 months of age. Adults depart rookeries in August. Females with pups remain within 500 km of their rookery during the non-breeding season, but juveniles of both sexes and adult males disperse more widely but remain primarily over the continental shelf (Wiles, 2015).

Despite the wide-ranging movements of juveniles and adult males in particular, until recently (the past 15–30 years) there has been little evidence that breeding adults emigrated from one stock to the other (except at adjacent rookeries at the DPS boundary) (Fritz et al., 2016; Hoffman et al., 2009; Jemison et al., 2013; Jemison et al., 2018; Muto et al., 2017; Muto et al., 2018b; Raum-Suryan et al., 2004; Trujillo et al., 2004). An analysis of over 4,000 Steller sea lions branded as pups between 2000 and 2010 from both the western and eastern DPSs revealed that juvenile males regularly crossed the DPS boundary and that there is "strong evidence" that some breeding females from the western DPS have permanently emigrated to and are reproducing in the eastern DPS (Fritz et al., 2016; Jemison et al., 2013; Raum-Suryan et al., 2004). These females are likely reproducing at rookeries at White Sisters and Grave Rocks, which are both located over 250 km north of the Behm Canal area. Females from the eastern DPS had a very low probability of migrating into the western DPS, and the majority of the overlap that does occur is present in the northern portion of Southeast Alaska (Fritz et al., 2016; Jemison et al., 2013; National Marine Fisheries Service, 2013b). Poor or declining environmental conditions in the west and favorable environmental conditions in the east are thought to have facilitated the migration of male and female Steller sea lions across the DPS boundary and resulted in higher survivability and reproductive success in the east (Jemison et al., 2013).

The locations and distribution of the Eastern population's breeding sites along the U.S. Pacific coast have shifted northward, with fewer breeding sites in Southern California and more sites established in Washington and Southeast Alaska (Pitcher et al., 2007; Wiles, 2015). Refer to the Navy's Marine Species Density Database Technical Report for more information on how abundance and distribution information was used to estimate species density (U.S. Department of the Navy, 2017g).

Offshore. Steller sea lions in the Offshore portion of the Study Area are from the Eastern stock, with the possible presence of occasional juvenile males from the Western stock. NMFS has determined that Western stock Steller sea lions are "extremely unlikely" to be present south of Sumner Strait near Wrangell Alaska (National Marine Fisheries Service, 2013b). For Washington's Pacific coast, there are unpublished reports of a branded Western DPS juvenile male Steller sea lion present in June 2005 on Tatoosh Island (at the entrance to Juan de Fuca) and another branded Western DPS juvenile male at the same general location and at Carrol Island (off southern Washington) in July and August 2013 (DeLong, 2018). Given this is an opportunistic sample, the presence of two Western DPS over the last 12 years suggests additional Western DPS animals may occasionally be present. However, juvenile male Steller sea lions wandering outside the core range of the population is not uncommon (Fritz et al., 2016; Jemison et al., 2013; Raum-Suryan et al., 2004). Given the NMFS characterization that the species' presence is extremely unlikely, the Navy's assumption is that the Western DPS animals should be absent or, at most, extremely few in number in the Study Area. The Navy considers the presence of Western DPS Steller sea lions to be discountable. Furthermore, it is unlikely that they may be present contemporaneously in time and space with Navy training and testing activities. Based on the current information and assumptions, the Proposed Action will not affect the ESA-listed Western DPS Steller sea lions.

Steller sea lion of the Eastern stock and DPS use haulout and breeding sites primarily along the Pacific coast from the Columbia River to Cape Flattery, as well as along the coast of Vancouver Island, British Columbia (Madson et al., 2017; Wiles, 2015; Wright et al., 2017a). The distance that female sea lions travel from rookeries and haulout sites during foraging trips depends on whether or not they have dependent young (e.g., nursing pups) (Merrick & Loughlin, 1997). Females in the Aleutian Islands with dependent young traveled an average distance of 17 km on foraging trips, whereas females without dependent young traveled an average of 133 km to seek out a wider variety of prey species (Merrick & Loughlin, 1997; Trites & Porter, 2002).

Outside of breeding season, Steller sea lions may be present throughout the Offshore Area. Their distribution is likely driven by the distribution of prey, which may be concentrated in areas where oceanic fronts and eddies persist (Lander et al., 2010; Sigler et al., 2017).

Based on 11 sightings along the Washington coast, Steller sea lions were observed at an average distance of 13 km from shore and 35 km from the shelf break (defined as the 200 m isobath) (Oleson et al., 2009). The mean water depth in the area of occurrence was 42 m, and surveys were conducted out to approximately 60 km from shore. Wiles (2015) estimated that Steller sea lions off the Washington coast primarily occurred within 60 km of land, favoring habitat over the continental shelf. However, a few individuals may travel several hundred kilometers offshore (Merrick & Loughlin, 1997; Wiles, 2015). The U.S. Geological Survey conducted seabird and marine mammal surveys off the coasts of Washington, Oregon, and Northern California in winter, summer, and fall from 2011 to 2012 (Adams et al., 2014). Steller sea lions were sighted infrequently, with a total of 4 sightings and 10 individuals, all observed over the continental shelf in depths less than 200 m. Three of the four sightings (and all but one individual) occurred in fall; the other occurred in winter (Adams et al., 2014). The locations and seasonality observed in the documented sightings were integrated into the distributions (U.S. Department of the Navy, 2020) used in the analysis of potential impacts from the Navy's Proposed Actions.

Inland Waters. Eastern stock Steller sea lions occur mainly along the Washington coast from the Columbia River to Cape Flattery (Jeffries et al., 2000; Madson et al., 2017; Wiles, 2015; Wright et al., 2017a). Smaller numbers use the Strait of Juan de Fuca, San Juan Islands, and Puget Sound south to the mouth of the Nisqually River in Thurston and Pierce counties (Wiles, 2015). A total of 22 haulouts used by Eastern Stock Steller sea lions (and other pinnipeds) are located in Washington inland waters, and an additional 6 sites are located on the Canadian side of the Strait of Juan de Fuca and southern Strait of Georgia (Jeffries, 2014; Wiles, 2015).

While Steller sea lions are occasionally observed in the Strait of Juan de Fuca, they are seasonally present in Puget Sound. An estimate of several dozen to a few hundred Steller sea lions (mostly males) are present in Puget Sound at any given time with peak abundance in fall and winter (Smultea et al., 2017). No sea lions were sighted from May through July during aerial surveys of Puget Sound from 2014 through 2016 (Smultea et al., 2017). However, aerial surveys conducted in 2013 and 2014 recorded peak abundance of over 600 Steller sea lions on Tatoosh Island at the mouth of the Strait of Juan de Fuca in late July (Jeffries, 2014). Jeffries (2014) identified five winter haulout sites in Puget Sound used by Steller sea lions, ranging from immediately south of Port Townsend (near Admiralty Inlet) and southern Puget Sound near Olympia. At these Puget Sound haulouts, the highest total count was 50 Steller sea lions recorded in the month of November (Jeffries, 2014). Although Steller sea lions may occur through Puget Sound, they have generally been observed in greater numbers in Admiralty Inlet (Smultea et al., 2017).

Steller sea lions have been seasonally documented at Naval Base Kitsap Bangor in Hood Canal since 2008 during daily haulout surveys (Jeffries, 2014; Jeffries et al., 2000; U.S. Department of the Navy, 2016). Aerial surveys conducted by the Washington Department of Fish and Wildlife in 2013 and 2014 recorded Steller sea lions hauled out on pontoons used as security barriers at Naval Base Kitsap Bremerton and Naval Station Everett (Jeffries, 2014). There is also a large sea lion haulout (used by California and Steller sea lions) near Manchester, approximately 8 miles from Naval Base Kitsap Bremerton. There are no known occurrences of Steller sea lions at Keyport or Crescent Harbor (Jeffries, 2014). Steller sea lions are seasonally present in large numbers in southern Puget Sound near Carr Inlet and off the mouth of the Nisqually River (Wiles, 2015).

Adjacent to the Study Area, Race Rocks is a well-established winter haulout site in the Canadian side of the Strait of Juan de Fuca used by hundreds of Steller sea lions as they enter inland waters to feed on herring (Edgell & Demarchi, 2012). Peak abundance at Race Rocks based on sightings from 1997 to 2009 occurred in October. During the summer breeding season, very few, if any, Steller sea lions would be expected in the Inland Waters portion of the Study Area (Jeffries, 2014; Smultea et al., 2017).

Western Behm Canal, Alaska. Steller sea lions from the Eastern U.S. stock are prevalent in southeast Alaska where over 65 percent of the population in U.S. waters resides (Table 3.4-1). The majority of rookeries and haulout sites in southeast Alaska are located north of the Behm Canal area (Jemison et al., 2013), and there are no haulout sites in Behm Canal. The closest haulouts are West Rock, located southwest of the southern end of Behm Canal, and Nose Point, located west of the northern end of Behm Canal (DeLong & Jeffries, 2017). The West Rock haulout is used by Steller sea lions year round, and the most recent counts of non-pups were 302 and 769 in late June of 2013 and 2015, respectively. The only winter count was 334 non-pups in December 1994. The haulout at Nose Point is used only in winter (DeLong & Jeffries, 2017). As noted above, Steller sea lions from the Western U.S. stock are not expected to be present in the Behm Canal portion of the Study Area, with the possible exception of a few wandering juvenile males (DeLong, 2018; Fritz et al., 2016; Jemison et al., 2013; National Marine Fisheries Service, 2013b). Western stock Steller sea lions are "extremely unlikely" to be present south of Sumner Strait (National Marine Fisheries Service, 2013b), which is approximately 70 NM north of waters in the vicinity of Behm Canal. For Southeast Alaska, the majority of the documented overlap of the two DPS in the east are in "northern Southeast Alaska," with only one to two additional animals documented at haulout locations along Alaska's Pacific Coast and as far south as Forrester Island (Jemison et al., 2013); this island in the Pacific is approximately 100 NM by sea from the entrance to Western Behm Canal so Steller sea lions are not expected to be in Western Behm Canal.

3.4.1.33 Guadalupe Fur Seal (*Arctocephalus townsendi*)

3.4.1.33.1 Status and Management

The Guadalupe fur seal is listed as depleted under the MMPA and threatened under the ESA, but there is no designated critical habitat for this species. The primary breeding rookery of Guadalupe fur seals is at Isla de Guadalupe, Mexico, and a second breeding population has been established at Islas San Benito, Baja California, Mexico (Esperon-Rodriguez & Gallo-Reynoso, 2012; Hernández-Camacho & Trites, 2018; Juárez-Ruiz et al., 2018; Maravilla-Chavez & Lowry, 1999; Norris, 2019). Guadalupe fur seals are considered by NMFS to be a single stock (Carretta et al., 2019c; Carretta et al., 2017c).

3.4.1.33.2 Abundance

Based on counts off Mexico in 2018 at Guadalupe Island and the San Benito Archipelago, the minimum population estimate was 29,747 Guadalupe fur seals at those locations (Norris, 2019). The most recent

SAR provides an average annual growth rate of 10.3 percent (Carretta et al., 2019a). Other research efforts (Hernández-Camacho & Trites, 2018; Norris, 2019; Ortega-Ortiz et al., 2019), have been consistent with the suggested increasing trend for the population, although the ongoing Unusual Mortality Event involving Guadalupe fur seals (National Marine Fisheries Service, 2019a; National Oceanic and Atmospheric Administration, 2018b) is likely to have impacted that trend (Elorriaga-Verplancken et al., 2016a; Elorriaga-Verplancken et al., 2016b; Ortega-Ortiz et al., 2019). Valdivia et al. (2019) has noted that since being ESA-listed in 1985, the population of the Guadalupe fur seal increased about ninefold at a rate of approximately 15 percent per year.

3.4.1.33.3 Distribution

Until recently the distribution of Guadalupe fur seals in the NWTT Study Area had been documented primarily through stranding records and archeological evidence (Aurioles-Gamboa & Camacho-Rios, 2007; Aurioles-Gamboa et al., 2010; Etnier, 2002; Lambourn et al., 2012; National Marine Fisheries Service, 2017a; Norris, 2017a; Rick et al., 2009). The dispersion of the species from rookeries off Mexico has been suggested to be an indicator of potential species recovery (Ortega-Ortiz et al., 2019). Norris (2017b, 2019) describes results of an on-going study tracking satellite-tagged fur seals as they migrate from rookeries on Isla de Guadalupe, Mexico and from rehabilitated fur seals released off of Point Reyes, California. Data from animals leaving Guadalupe Island indicate that Guadalupe fur seals primarily use habitats offshore of the continental shelf between 50 and 300 km from the U.S. West Coast, with approximately one quarter of the population foraging farther out and up to 700 km offshore (Norris, 2017b). While a small percentage of adult and juvenile fur seals may migrate north of Point Cabrillo, California, and into the NWTT Study Area, the majority of these individuals are likely weaned pups and yearlings less than two years old. Several rehabilitated fur seals between 10 and 15 months old were fitted with satellite tracking tags and released off Point Reyes, California from 2015 through 2017 (Norris, 2017b). Several of these animals remained close to shore as they migrated north and spent most of their time over the continental shelf. In contrast, “wild” Guadalupe fur seal pups and yearlings that migrated from Isla de Guadalupe, Mexico after the breeding season remained seaward of the continental shelf in deep pelagic waters. Even though the rehabilitated fur seals tended to remain closer to shore, they are not considered representative of the population as a whole, which is expected to remain in pelagic waters beyond the continental shelf. Healthy Guadalupe fur seals are not expected to haul out in the Study Area (Norris, 2017b). Sightings of live animals off Washington and Oregon are more limited, although there is photo documentation of apparently healthy Guadalupe fur seals in offshore waters of Washington and British Columbia during summer and early autumn (Lambourn et al., 2012).

Refer to the Navy’s Marine Species Density Database Technical Report for more information on how abundance and distribution information was used to estimate species density (U.S. Department of the Navy, 2017g).

Offshore. During the summer breeding season adult and juvenile Guadalupe fur seals are mainly distributed offshore of Baja California, Mexico around rookeries on Isla de Guadalupe and Islas San Benito, Baja California, Mexico (Esperon-Rodriguez & Gallo-Reynoso, 2012; Juárez-Ruiz et al., 2018; Maravilla-Chavez & Lowry, 1999). During other times of the year, adult and juvenile fur seals, particularly males, are more widely distributed; however, very few are expected to migrate into the Study Area (Norris, 2017b, 2019). A large percentage of weaned pups and yearlings (fur seals less than two years old) are likely to migrate into the Offshore Area and remain there year round, with greater abundance expected from May to at least November (in summer and fall). Several rehabilitated fur seals between 10 and 15 months old were fitted with satellite tracking tags and released off Point Reyes, California from 2015 through 2017 (Norris, 2017b). Several of these animals remained close to shore as they migrated north and spent most of their time over the continental shelf. In contrast, "wild" Guadalupe fur seal pups and yearlings that migrated from Isla de Guadalupe, Mexico after the breeding season remained seaward of the continental shelf in deep pelagic waters. Even though the rehabilitated fur seals tended to remain closer to shore, they are not considered representative of the population as a whole, which is expected to remain in pelagic waters beyond the continental shelf. Healthy Guadalupe fur seals that are not at a rookery are not expected to haul out in the Study Area (Norris, 2017b). Adult Guadalupe fur seals are known to forage primarily off the continental shelf (beyond the 200 m isobath) in pelagic waters. Their preferred prey is squid and other cephalopods, with pelagic and benthic species of fish constituting a smaller fraction of their diet (Gallo-Reynoso & Esperón-Rodríguez, 2013; Juárez-Ruiz et al., 2018; Norris, 2019). Foraging in coastal waters is not uncommon; however, the pursuit of prey can take them out to at least 300 km from shore, and it would not be uncommon to encounter fur seals foraging 700 km from shore (Norris, 2017b). The Navy has assumed that Guadalupe fur seals will be present at sea in the Offshore portion of the NWTT Study Area.

Inland Waters. Guadalupe fur seals are pelagic outside of the breeding season and are not expected to occur within the Inland Waters portion of the Study Area at any time.

Western Behm Canal, Alaska. Guadalupe fur seals are not expected to occur within the Western Behm Canal portion of the Study Area (Norris, 2017b).

3.4.1.34 Northern Fur Seal (*Callorhinus ursinus*)

3.4.1.34.1 Status and Management

NMFS has identified two stocks of northern fur seals in U.S. waters in the North Pacific: the Eastern Pacific stock and the California stock (Carretta et al., 2019c; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). The Eastern Pacific stock of northern fur seals is listed as depleted under the MMPA and is not listed under the ESA. The California stock of northern fur seals is not considered to be depleted under the MMPA and is not listed under the ESA. The stocks are differentiated based on high natal site fidelity and substantial differences in population dynamics. The Eastern Pacific stock breeds primarily on the Pribilof Islands (located in the Bering Sea), and the California stock breeds on San Miguel Island off Southern California and the Farallon Islands off central California (Carretta et al., 2019c; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). The distribution of the stocks overlaps during the non-breeding season and individuals from both stocks may be present in the Study Area.

3.4.1.34.2 Abundance

The abundance of the Eastern Pacific stock is currently estimated to be 620,660 animals (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a), and the California stock is estimated to have an abundance of 14,050 fur seals (Carretta et al., 2019c; Carretta et al., 2017c). Adult male northern fur seals comprise approximately 7 percent of the population (43,871 fur seals) and in general are not expected to be in the Study Area at any time given their North Pacific mid-ocean foraging when not otherwise in the Pribilof Islands (Olesiuk, 2012).

3.4.1.34.3 Distribution

The northern fur seal is endemic to the North Pacific Ocean and occurs from Southern California to the Bering Sea, the Okhotsk Sea, and Honshu Island, Japan. Northern fur seals are on shore at breeding sites and haulouts outside of Study Area from mid-May through mid-November (summer and fall) and at sea the remaining half of the year (winter and spring) (Carretta et al., 2019c; Carretta et al., 2017c; Gelatt & Gentry, 2018; Kuhn et al., 2020; Lee et al., 2014; Melin et al., 2012; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). Males move ashore at breeding sites in the Pribilof Islands from May to mid-August (depending on age) and remain on shore until October (National Marine Fisheries Service, 2007b; Zeppelin et al., 2019). After the breeding season, adult males move into the Gulf of Alaska north of the Study Area (Olesiuk, 2012; Sterling et al., 2014). Females arrive at breeding sites in June, pup in July, and leave in October or November. Pups are born from June through August and leave breeding sites in November, after the adults. Seasonal migrations begin in November with fur seals transiting through Aleutian Islands. Satellite tag location data indicates that while a majority of northern fur seal population remains at sea foraging in the north Pacific, a small portion of the females and juvenile males move south off the coasts of Southeast Alaska, British Columbia, Washington, Oregon, and California to forage and occasionally haul out on those coastlines (Zeppelin et al., 2019). The smaller breeding population from San Miguel Island and the Farallon Islands migrates north into the Study Area after the breeding season, arriving in the region in November and December. The return migration begins in March (Carretta et al., 2019c; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). Refer to the Navy's Marine Species Density Database Technical Report for more information on how abundance and distribution information was used to estimate species density (U.S. Department of the Navy, 2017g).

Offshore. Northern fur seals are mainly pelagic in the Study Area occurring in oceanic waters far from shore. Their offshore distribution has been correlated with oceanographic features (e.g., eddies and fronts) where prey may be concentrated (Kuhn et al., 2015; Olesiuk, 2012; Ream et al., 2005; Sterling et al., 2014). Sightings are more common off the northern Washington and Vancouver Island coasts in winter and off central and southern Oregon in spring. Based on visual detections off Washington, Oleson (2009) described northern fur seals as occurring an average of 55 km from shore, 11 km from the 200 m isobath (a proxy for the shelf break), and in waters with a mean depth of 754 m. Kenyon and Wilke (1953) summarized information from a number of disparate sources, including sealing records and U.S. Coast Guard observations, on the migration of northern fur seals in the North Pacific. Migrating fur seals were generally found from 10 to 50 miles from shore in depths of thousands of feet (Kenyon & Wilke, 1953).

Kajimura (1984) analyzed the stomach contents of fur seals captured in the eastern North Pacific from 1958 to 1974 to better understand their foraging behavior and distribution. While the fur seals were widely distributed at sea and fed opportunistically, they were most frequently sighted between 70 and 130 km from shore, over outer continental shelf and slope. Olesiuk (2012) characterized northern fur seals as ubiquitous in the North Pacific between 60° N and 40° N latitude with their distribution at sea driven by prey concentrations associated with oceanographic features such as the boundary of the sub-arctic – sub-tropical transition zone near 42° N latitude (Polovina et al., 2001).

The U.S. Geological Survey conducted seabird and marine mammal surveys off the coasts of Washington, Oregon, and Northern California in winter, summer, and fall from 2011 to 2012 (Adams et al., 2014). Northern fur seals were sighted 35 times (47 individuals) primarily in winter and fall, with very few sightings in summer. The number of sightings and relative abundance increased with depth and distance from shore. Northern fur seals were most frequently observed beyond the-continental shelf (200 m isobath) with over 83 percent of sightings and individuals observed at depths between 200 and 2,000 m (Adams et al., 2014). Fall and winter surveys off Washington in 2016–2019 sighted a total of 58 northern fur seals at an average distance of 52 km from shore (Pearson, 2019).

Pelland et al. (2015) examined the migratory behavior of 40 satellite-tagged female northern fur seals following their departure from breeding grounds on Bogoslof and St. Paul islands in the Aleutian Islands, Alaska. This study concentrated on foraging in the waters off Washington, but the tagged fur seals foraged along the Pacific Coast from British Columbia to central California and as far out to as approximately 620 km from the shelf break (defined in the study as the 200 m isobath). The tracking data spanned seven migratory seasons from 2002 to 2010 and were compared with oceanographic data gathered from autonomous gliders deployed over the same time period and in proximity to seals' satellite tracks. A seal's extended presence in a relatively limited spatial area was presumed to represent foraging behavior and frequently coincided in space and time with oceanographic features such as eddies, fronts, chlorophyll concentrations, and river plumes within 200 km of the continental shelf break. The median (50 percent of time spent) of the cross-shore distribution had a maximum of 260 km in January and minimum of 71 km in May, presumably shifting in response to dynamic mesoscale circulation and surface wind changes. One of the 40 tagged seals spent several weeks in the spring and early summer of 2007 following the Columbia River plume as it shifted with downwelling and upwelling favorable winds, primarily seaward of the shelf break, consistent with findings from the other tagged northern fur seals in the study (Pelland et al., 2015).

Inland Waters. The northern fur seal is a highly oceanic species. Some individuals, mostly juveniles, make their way into the Strait of Juan de Fuca and Puget Sound each year (Everitt et al., 1980), albeit not in large numbers or with any regularity. Aboriginal sealers have also reported their presence within the entrance of the Strait of Juan de Fuca (Kenyon & Wilke, 1953). Northern fur seals rarely haul out on land during migrations and would not be expected at haulouts along the coast or inland (Bonnell & Dailey, 1993). As a result of the available information, the Inland Waters of the Puget Sound are an area of rare occurrence for this species.

Western Behm Canal, Alaska. Satellite tracking data of female northern fur seals tagged at locations in the Bering Sea documented all bypassing the inland waters are of Southeast Alaska as they crossed the North Pacific to the continental margin of northwestern North America (Melin et al., 2012; Ream et al., 2005; Sterling et al., 2014). The tracks are consistent with the historic distribution recorded by sealing operations, which occurred only along the Pacific Coast and did not include the inland waters of Southeast Alaska (Olesiuk, 2012). Adult male fur seals remain in colder waters and are distributed in an expansive region of the North Pacific, Aleutian Islands, Gulf of Alaska, and the Bering Sea in a foraging strategy different than that of females and younger males (National Marine Fisheries Service, 2007b; Sterling et al., 2014). Northern fur seals from San Miguel Island appear to migrate only as far north as the Washington border and not to southeast Alaska. Kenyon and Wilke (1953) reported observations of a few thousand adult female northern fur seals regularly entering inlets of southeastern Alaska to forage during the winter-spring herring runs. The herring fishery is currently closed in Behm Canal, so no fishing vessels are on site to record the presence or absence of northern fur seals; however, the fur seals are likely there from February through April (i.e., spring) but not at other times of the year (DeLong & Jeffries, 2017).

3.4.1.35 Harbor Seal (*Phoca vitulina*)

3.4.1.35.1 Status and Management

There are no harbor seals listed under the ESA in the Study Area and no designated critical habitat. For management purposes under the MMPA, differences in mean pupping date, movement patterns, pollutant loads, and fishery interactions have led NMFS to recognize 17 stocks within U.S. waters from California to Alaska (Carretta et al., 2019c; Carretta et al., 2017c; Muto et al., 2017; Muto et al., 2018b;

Muto et al., 2019a). As shown in Table 3.4-1, out of these 17 stocks there are 6 present in the Study Area. The Clarence Strait stock is the only stock within the Western Behm Canal portion of the Study Area (Muto et al., 2018b; Muto et al., 2019a). Within U.S. West Coast waters (excluding Alaska), five stocks of harbor seals are recognized: (1) Oregon/Washington Coast, (2) California, (3) Washington Northern Inland Waters (including Puget Sound north of the Tacoma Narrows Bridge, the San Juan Islands, and the Strait of Juan de Fuca); (4) Southern Puget Sound (south of the Tacoma Narrows Bridge), and (5) Hood Canal (Carretta et al., 2019c; Carretta et al., 2017c).

3.4.1.35.2 Abundance

Harbor seals are the most abundant pinniped in the Pacific Northwest. They occur in coastal waters over the continental shelf, in bays and estuaries, and in the inland waters of Washington (Ashley et al., 2020; Huber et al., 2001). The harbor seal population in the Inland Waters portion of the NWTT Study Area has been at equilibrium since the mid-1990s (Ashley et al., 2020). Abundances for the six stocks occurring in the Study Area are presented below.

Clarence Strait Stock: The abundance of the Clarence Strait population of harbor seals was estimated to be 31,634 (Muto et al., 2018b; Muto et al., 2019a). The current estimate of the Clarence Strait population trend is +921 seals per year as provided by NMFS (Muto et al., 2018b; Muto et al., 2019a).

California Stock: Based on the most recent harbor seal counts (20,109 animals in May–July 2012) and a correction factor of 1.54 to account for the number of animals in the water during the time of the survey, the harbor seal population in California is estimated to be 30,968 seals (coefficient of variation = 0.157) (Carretta et al., 2019c; Carretta et al., 2017c). Trend analysis in Carretta (Carretta et al., 2019c; 2017a) and preliminary analysis of recent abundance data by the Washington Department of Fish and Wildlife DeLong (2017) indicate that the California stock of harbor seals is at carrying capacity, and the current abundance estimate is applicable.

Oregon/Washington Stock: Aerial surveys were conducted offshore in Oregon and Washington during the 1999 pupping season. Radio-tagging studies in 1991 and 1992 were considered and a correction factor was applied to account for animals in the water during the time of the survey. Based on that analysis, the most recent population estimate for the Oregon/Washington stock is 24,732. NMFS SARs do not estimate abundance based on data more than eight years old; however, trend analysis in (Carretta et al., 2019c; Carretta et al., 2017c) and preliminary analysis of recent abundance data by the Washington Department of Fish and Wildlife DeLong (2017) indicate that the Oregon/Washington stock of harbor seals is at carrying capacity, and the current abundance estimate is appropriate.

Washington Northern Inland Waters Stock: The Navy sponsored aerial surveys of marine mammals, particularly harbor seals and harbor porpoises, from the summer of 2013 through the winter of 2016 in Puget Sound to update seasonal, in-water abundance and density estimates in proximity to Navy facilities in the inland waters portion of the Study Area (Smultea et al., 2017). An in-water abundance estimate of 3,116 harbor seals in the Washington Northern Inland Waters stock was calculated based on pooling seasonal data for the Admiralty Inlet, East Whidbey, and South Whidbey strata. Note that this in-water abundance is not equivalent to the total number of harbors seals in the stock, because it does not account for hauled-out seals. Calculating the total stock abundance based on in-water surveys and separate counts of hauled-out seals is not straightforward and presents several challenges. For example, aerial surveys are conducted at randomly chosen times, but counts of hauled-out seals are typically conducted at high tide (Jefferson et al., 2017). Simply summing the two totals would invariably result in an overestimate of abundance. This abundance estimate presented above is currently the most appropriate.

Southern Puget Sound Stock: The aerial surveys conducted by Smultea et al. (2017) from 2013 through 2016 also included Puget Sound. An in-water abundance estimate of 4,042 harbor seals in the Southern Puget Sound stock was calculated based on pooling seasonal data for the Bainbridge, Seattle, Southern Puget Sound, and Vashon strata. Note that this is an in-water abundance estimate and does not represent the abundance of the entire stock. This abundance estimate is currently the most appropriate.

Hood Canal Stock: Jefferson et al. (2017) analyzed aerial survey data for Hood Canal collected during the same surveys reported on by Smultea et al. (2017). To calculate seasonal in-water abundance and density estimates for harbor seals in Hood Canal, Jefferson et al. (2017) divided the canal into six sub-regions and calculated separate estimates for each sub-region in each season (winter, spring, summer, and fall). As noted above, calculating a total abundance for harbor seals in Hood Canal based solely on aerial surveys is problematic; however, Jefferson et al. (2017) estimate that there are approximately 2,000 harbor seals in the Hood Canal stock.

Refer to the Navy's Marine Species Density Database Technical Report for more information on how abundance and distribution information was used to estimate species density (U.S. Department of the Navy, 2017g).

3.4.1.35.3 Distribution

Harbor seals are a coastal species, rarely found more than 25–30 km from shore, and frequently occupy bays, estuaries, and inlets (Bailey et al., 2014; Baird, 2001; Oleson et al., 2009). Ideal harbor seal habitat includes access to numerous haulout sites, shelter during the breeding periods, and sufficient food (London et al., 2012; Peterson et al., 2012; Simpkins et al., 2003; Womble et al., 2015). Haulout areas can include intertidal and subtidal rock outcrops, sandbars, sandy beaches, peat banks in salt marshes, and human-made structures such as log booms, docks, and recreational floats (Jefferson et al., 2017; Jeffries, 2014; Jeffries et al., 2000; London et al., 2012; Smultea et al., 2017). Harbor seals in the Study Area may be hauled out approximately 65 percent of time; although, duration can vary by season, sex, and lifestage (Huber et al., 2001). Harbor seals do not make extensive pelagic migrations, showing strong fidelity to breeding and haulout locations year round (Carretta et al., 2019c; Carretta et al., 2017c), some long distance movement of tagged animals in Alaska (108 miles) and along the U.S. West Coast (up to 342 mi.) have been recorded (Brown & Mate, 1983; Womble & Gende, 2013).

Offshore. Harbor seals occur in the Offshore Area year round (Carretta et al., 2019c; Carretta et al., 2017c; Jeffries et al., 2003). They spend most of their time within 25–30 km from shore and haul out frequently along the coastline (Bailey et al., 2014; Oleson et al., 2009). Visual and acoustic surveys conducted off the Washington coast noted that a few harbor seals were sighted out to 64 km from shore, with farthest sighting at 70 km from shore and near the 1,000 m isobath, particularly in spring, indicating that they do range into deeper waters (Oleson et al., 2009). The U.S. Geological Survey conducted seabird and marine mammal surveys off the coasts of Washington, Oregon, and Northern California in winter, summer, and fall from 2011 to 2012 (Adams et al., 2014). Harbor seals were the second most frequently sighted pinniped (out of 5 species), with a total of 40 sightings and 56 individuals observed. Harbor seals occurred in all three seasons but were most frequently sighted in winter when 50 percent of sightings and 63 percent of individuals occurred. Consistent with other coastal surveys, 93 percent of sightings and all but three individuals occurred in water depths less than

100 m, and the remaining harbor seal observations were in depths between 100 and 200 m (i.e., over the continental shelf) (Adams et al., 2014).

Inland Waters. The harbor seal is the most common, widely distributed pinniped found in Washington inland waters, and is frequently observed by recreational boaters, ferry passengers and other users of the marine environment (Jeffries, 2014). Gaydos et al. (2013) have suggested that San Juan County, Washington, might have one of the most dense harbor seal populations in the world. Harbor seals are the most abundant marine mammal in Puget Sound and Hood Canal in particular, where they occur throughout the canal year round (Jefferson et al., 2017). London et al. (2012) identified five locations in Hood Canal as "major harbor seal haul-out sites" and noted these were locations having documented human (non-Navy) disturbance. London et al. (2012) report that disturbance occurs on a regular basis and described that disturbance for four of the five sites as follows: Quilcene Bay—operational salmon net-pen floats and oyster rafts; Dosewallips—state park and marina with motorized boats, kayakers, and canoers; Hamma Hamma—working oyster farm; and Skokomish—a kayak rental facility and a tribal and commercial fisheries site. Harbor seals also haul out year round at Navy facilities, including at Naval Base Kitsap Bangor located along Hood Canal, Naval Station Everett, the Manchester Fuel Depot, and Naval Base Kitsap Bremerton in Puget Sound (Jeffries, 2014; Jeffries et al., 2000).

In southern Puget Sound, harbor seals haul out on a variety of substrate materials including intertidal beaches, reefs, sandbars, log booms and floats. There are five main harbor seal haulout areas including mouth of the Nisqually River, Cutts Island, Gertrude Island, Eagle Island, and Woodard Bay (Lambourn et al., 2010). Based on periodic aerial and boat surveys, each of these sites regularly supports a population of over 100 seals (Lambourn et al., 2010). Pupping seasons vary by geographic region, with pups born in coastal estuaries (Columbia River, Willapa Bay, and Gray Harbor) from mid-April through June; Olympic Peninsula coast from May through July; San Juan Islands and eastern bays of Puget Sound from June through August; southern Puget Sound from mid-July through September; and Hood Canal from August through January (Jeffries et al., 2000). Historically, harbor seals were thought to remain within approximately 30 km of established haulout sites; however, Peterson et al. (2012) reported on 8 out of 14 satellite-tagged males captured east of the San Juan Islands moving more than 100 km from their haulout. The results of the study also support the hypothesis that males are moving between the Oregon/Washington coastal stock and the Washington Northern Inland Waters stock and potentially mating in both locations.

Western Behm Canal, Alaska. Harbor seals from the Clarence Strait stock occur year round in southeast Alaska (Muto et al., 2017; Muto et al., 2018b; Muto et al., 2019a). As in other regions, harbor seals haul out along the coastline and on human-made structures, and they also will use glacial ice as haulouts in southeast Alaska. During the summer molting season they spend only about 19 percent their time in the water (Simpkins et al., 2003). The rest of the year they are in the water about 43 percent of the time (Huber et al., 2001). Withrow et al. (1999) counted harbor seals at numerous sites along the eastern coast of Prince Edward Island adjacent to Clearance Strait and at haulouts in eastern Behm Canal during August of 1999. The counts were averaged over each survey data and summed to equal over 5,400 harbor seals. No sites in western Behm Canal were surveyed, however, harbor seals are expected to be present in western of Behm Canal.

3.4.1.36 Northern Elephant Seal (*Mirounga angustirostris*)

3.4.1.36.1 Status and Management

The northern elephant seal is protected under the MMPA and is not listed under the ESA. There are rookeries on islands off Mexico and rookeries in central California and the Channel Islands, but because there is no international agreement between Mexico and the U.S. for the joint management of this species, NMFS only recognizes and counts elephant seals present in U.S. waters at the California rookeries; NMFS has defined one stock for the northern elephant seals present in U.S. Waters, designated the California Breeding stock (Carretta et al., 2019c; Carretta et al., 2017c). The abundance numbers provided for elephant seals are based only on those elephant seals counted at U.S. rookeries although elephant seals from Mexico and U.S. waters overlap across their range when not at their rookeries (Robinson et al., 2012), which includes the NWTT Study Area.

3.4.1.36.2 Abundance

Lowry et al. (2014) reported that 40,684 pups were born on U.S. rookeries in 2010. Based on the pup count, the population estimate in the California Breeding stock is approximately 179,000 elephant seals. Assuming an annual growth rate of 3.8 percent as provided by NMFS, the projected 2017 abundance is 232,399 elephant seals potentially transiting the North Pacific ocean including the Offshore Area (Carretta et al., 2019c; Carretta et al., 2017c; Lowry et al., 2014).

Based on data from Jeffries (2014) and (DeLong & Jeffries, 2017), an abundance of 13 juvenile elephant seals was used for the analysis in this supplemental in the Inland Waters portion of the Study Area.

Only approximately 10 percent of male elephant seals are expected to enter Behm Canal and only in fall and spring (DeLong & Jeffries, 2017; Le Boeuf et al., 2000). An estimate of the male population based on the 2010 pup count and a multiplication factor of 3.88 is 78,926 (Lowry et al., 2014). Based on the assumption that 10 percent of males use inland waters in Alaska, a baseline abundance of 7,893 male elephant seals was used for the analysis in this supplemental for the Western Behm Canal portion of the Study Area.

3.4.1.36.3 Distribution

Northern elephant seals breed on islands offshore and mainland rookeries in California and Baja California, Mexico from December to March (Lowry et al., 2014). It has been suggested that since the 1990s, elephant seals in Mexico are not returning as far south as they had in the past due to warming sea and air temperatures (Garcia-Aguilar et al., 2018), which would shift their general distribution into more northern waters. Following the breeding season, they migrate north with male elephant seals migrating to the Gulf of Alaska and western Aleutian Islands while feeding along the continental shelf and females moving farther offshore into pelagic waters in the Gulf of Alaska and central North Pacific (Abrahms et al., 2017; Carretta et al., 2017c; Le Boeuf et al., 2000). Between March and August, adults return to land, primarily in the Aleutian Islands to molt. Females arrive in March and April while males arrive later in July and August (Robinson et al., 2012; Stewart & DeLong, 1995). After molting both adult males and females return to sea to feed in spring and summer before making the return migration to breeding colonies in California and Mexico. There are rookeries as far north as Northern California at the Farallon Islands, Point Reyes, and Castle Rock off Crescent City (Hodder et al., 1998; Lowry et al., 2014). Le Boeuf (2000) reports that 20 males fitted with satellite-tags at California breeding rookeries migrated to feeding areas off the coast of eastern Alaska and noted that all feeding areas were located near the continental shelf break. One male was tracked to the “inland passage” of southern Alaska. Robinson (2012) used satellite tracking data from 297 adult female elephant seals to show that post breeding and post molting foraging areas were primarily offshore in the North Pacific at the convergence of the sub-arctic and sub-tropical gyres. Peterson et al. (2015) also showed that satellite-tagged female seals migrated northwest into offshore waters of the North Pacific.

Refer to the Navy's Marine Species Density Database Technical Report for more information on how abundance and distribution information was used to estimate species density (U.S. Department of the Navy, 2017g).

Offshore. Adult male elephant seals migrate north, primarily to Alaska, following the winter breeding season. Out of 26 males tracked from rookeries off Mexico, 20 migrated to the Alaska coast, 4 terminated their migration off Canada, 2 remained off of Oregon, and 1 migrated to the Washington coast (Le Boeuf et al., 2000). Migrating elephant seals did not linger during migrations and moved steadily and directly to their destinations during north and south bound migrations. After reaching their destination, they foraged in the area for 1–3 months. Male elephant seals are most likely to transit through the Offshore Area over approximately 30 days in March/April (northbound), June/July (southbound), August/September (northbound), and November/December (southbound) during migrations associated with breeding and molting periods (DeLong & Jeffries, 2017; Le Boeuf et al., 2000; Stewart & DeLong, 1995). Female elephant seals primarily migrated and foraged farther offshore than males, which are primarily benthic feeders, but satellite-tagged females and males followed similar migration routes (Le Boeuf et al., 2000; Robinson et al., 2012; Simmons et al., 2007).

Elephant seals were sighted during aerial surveys off the Washington coast from 2004 through 2008 (Oleson et al., 2009). Sightings occurred an average of 59 km off the coast, with most seals sighted approximately 70 km from shore and near the 1,000 m isobath. The elephant seals were an average of 13 km west of the shelf break (200 m isobath), indicating that they were foraging and migrating off the continental shelf. While migrating adult elephant seals tend to stay offshore, juveniles and sub-adults have been seen closer to shore along the coasts of Oregon, Washington, and British Columbia (Condit & Le Boeuf, 1984; Stewart & Huber, 1993). The U.S. Geological Survey conducted seabird and marine mammal surveys off the coasts of Washington, Oregon, and Northern California in winter, summer, and fall from 2011 to 2012 (Adams et al., 2014). Observers sighted northern elephant seals 31 times (33 individuals), and sightings were distributed fairly evenly across strata ranging from depths of 0 to 2,000 m. Sightings were also uniformly distributed over all three seasons (Adams et al., 2014).

Inland Waters. Jeffries (2014) observed one to three juvenile elephant seals during surveys from April to November 2013 at haulout sites in the eastern end of the Strait of Juan de Fuca. The elephant seals were hauled out with harbor seals, and the sightings were distributed evenly over the survey period. A few individuals have been seen hauled out on beaches at Destruction Island, Protection Island, and Smith and Minor islands as well as Dungeness Spit (Jeffries et al., 2000). Individuals have also been seen hauled out on Race Rocks on the Canadian side of the Strait of Juan de Fuca. Solitary individuals may occasionally be seen farther inland than the Strait of Juan de Fuca, but substantial numbers of northern elephant seals are not expected to occur in Hood Canal or Puget Sound (DeLong & Jeffries, 2017). No regular haulout sites occur in Puget Sound, however, individual elephant seals occasionally haul out for two to four weeks to molt, usually during spring and summer, and typically on sandy beaches (Calambokidis & Baird, 1994). These animals are typically yearlings or sub-adults, and their haulout locations are unpredictable. The National Stranding Network database reported one male subadult elephant seal hauled out to molt at Manchester Fuel Depot in February 2004. Rat Island across the bay from the Port Townsend ferry terminal is occasionally used by juvenile elephant seals. Most reported haulout sites are in the Strait of Juan de Fuca, and the occurrence of elephant seals in the Puget Sound region would occur infrequently and most likely during the molting season.

Migration routes of satellite-tagged adult elephant seals all remained offshore (Abrahms et al., 2017; Le Boeuf et al., 2000; Robinson et al., 2012; Simmons et al., 2007), so considering that and the other information presented above, the Navy has assumed those few individuals observed hauled out in Inland Waters are juveniles and constitute an extremely small fraction of the northern elephant seal population.

Western Behm Canal, Alaska. A small number of male northern elephant seals may be present in Behm Canal for brief periods in fall (September to November) and spring (April to June). The deep water (approximately 600 m) in the canal is consistent with foraging habitat preferred by male elephant seals (DeLong & Jeffries, 2017). The elephant seals would not be expected to haul out while in Behm Canal. Le Boeuf et al. (2000) noted that 2 out of 20 (10 percent) tagged males used inland waters in southeast Alaska and Puget Sound. This ratio was used to estimate the abundance of male elephant seals potentially entering Behm Canal to forage, which as noted above is approximately 8,000 and is the number of animals assumed present in the analysis undertaken for this Supplemental.

Mustelidae

3.4.1.37 Northern Sea Otter (*Enhydra lutris kenyoni*)

3.4.1.37.1 Status and Management

Sea otters that occur along the coast of Washington are the result of reintroduction efforts of the northern sea otter (from Amchitka Island, Alaska) in 1969 and 1970 (Lance et al., 2004; Sato, 2018) are not listed as threatened or endangered under the ESA (Carretta et al., 2017c; U.S. Fish and Wildlife Service, 2018). The Washington stock is not classified as strategic because the population is growing and is not listed as depleted under the MMPA. The State of Washington developed a recovery plan to address the northern sea otter population in its waters (Lance et al., 2004; Sato, 2018). The USFWS recognizes five northern sea otter stocks in U.S. waters under MMPA guidelines. There is a single stock in Washington waters (the northern sea otter [*Enhydra lutris kenyoni*]); and a single stock in California (the southern sea otter [*Enhydra lutris nereis*]). Only the Washington stock of sea otter occurs in the Study Area (Carretta et al., 2017c; U.S. Fish and Wildlife Service, 2018). There are three sea otter stocks in Alaska that are designated Southeast, Southcentral, and Southwest stocks (Muto et al., 2019a). The boundaries of the Southcentral and the Southwest stocks are far from the Study Area and the Southeast Alaska stock is not known to be present in the western Behm Canal portion of the Study Area since they routinely only inhabit the Pacific Coast in southeast Alaska (Muto et al., 2018a; Muto et al., 2018b; Muto et al., 2019a) and were not observed during the most recent surveys of the area (Tinker et al., 2019).

The USFWS has previously determined that for the intensively monitored Southern sea otter population at San Nicolas Island off California, Department of Defense actions have not posed a threat to sea otters and do not trigger any regulatory requirements pursuant to the MMPA or ESA (National Oceanic and Atmospheric Administration, 2014c; U.S. Department of the Navy, 2002; U.S. Department of the Navy et al., 2016; U.S. Fish and Wildlife Service, 2012, 2015). The Navy has determined that the findings by the U.S. Fish and Wildlife Service also apply to Northern sea otters in Washington and the same Navy activities occurring in the NWTT Study Area. The Navy has also determined that sea otter are unlikely to co-occur in the Offshore portion of the Study Area contemporaneously with Navy training and testing activities.

3.4.1.37.2 Abundance

The Washington population of sea otters has continued to increase since the initial reintroduction of 59 individuals in 1969 and 1970 (U.S. Fish and Wildlife Service, 2018; White et al., 2018). Population growth has averaged 9.8 percent per year since 1989, and the numbers of sea otters have increased with the 2019 minimum population estimate at 2,785 individuals (Jeffries et al., 2019; Sato, 2018).

3.4.1.37.3 Distribution

Sea otters occupy nearly all coastal marine habitats, from bays and estuaries to rocky shores exposed to oceanic swells (Bodkin, 2015; Calambokidis et al., 1987; Fisheries and Oceans Canada, 2015b; Hale et al., 2019; Jeffries et al., 2016b; Riedman & Estes, 1990; U.S. Geological Survey, 2014; Yeates et al., 2007). Although sea otters prefer rocky shoreline and relatively shallow water (up to 40 m deep) with kelp beds, this is not an essential habitat requirement, and some individuals use soft-sediment areas where kelp is absent (Laidre et al., 2009; Muto et al., 2017; Riedman & Estes, 1990; Sato, 2018). In the Pacific Northwest, sea otters generally occupy coastal areas exposed to the open Pacific Ocean along shorelines characterized by jagged coastlines with clusters of small islets and reefs and shallow variable depths (Fisheries and Oceans Canada, 2015b; Hale et al., 2019; Jeffries et al., 2019; Laidre et al., 2009; Nichol et al., 2015; Walker et al., 2008). Sea otters seldom range more than 2 km from shore, because they are benthic foragers and limited by their ability to dive to the seafloor; although some individuals, particularly juvenile males, travel farther offshore (Bodkin, 2015; Bodkin et al., 2004; Calambokidis et al., 1987; Hale et al., 2019; Laidre et al., 2009; Muto et al., 2017; Pearson, 2019; Riedman & Estes, 1990). In Alaska, home territories are relatively small, ranging from 4 to 11 square kilometers for males and from a few to 24 square kilometers for adult females (Bodkin, 2015; Bodkin et al., 2004; Muto et al., 2017; Tinker et al., 2019). In Washington, observations have indicated female sea otters were most frequently found resting and foraging in shallow waters between 0 and 10 m in depth, whereas males rested and foraged farther offshore where water depths were between 10 and 40 m (Hale et al., 2019; Laidre et al., 2009; Walker et al., 2008). Sea otters move seasonally to areas where there is food or where sheltered water offers protection from storms and rough seas (Laidre et al., 2009; Lance et al., 2004; Riedman & Estes, 1990; Sato, 2018). Results from 75 sea otters radio-tagged off Washington indicated adult males had the largest home ranges along the coastline (50 ± 9 km), adult females had significantly smaller home ranges (38 ± 10 km), and subadult females used the least area of coastline (24 ± 9 km) for a home range. In Washington waters, otters range along a roughly 130-km stretch of the coast from Point Grenville in the south to Pillar Point on the Strait of Juan de Fuca year round (Jeffries et al., 2016b; Laidre et al., 2009; Lance et al., 2004; Sato, 2018). In recent years, the majority of the sea otter population in Washington (approximately 75 percent) has been present south of La Push (Hale et al., 2019; Jeffries et al., 2016b; Sato, 2018).

Offshore. Aerial and ground sea otter surveys conducted along the Washington coast in June/July since 1989 have included the area extending from the mouth of the Columbia River into the Strait of Juan de Fuca to approximately Port Angeles (Jeffries & Jameson, 2014; Jeffries et al., 2016a, 2016b; Sato, 2018), so the distribution of sea otters has been well established. Given that sea otters seldom range farther than 2 km from shore (which is why survey counts can be made by land-based observers; see Hale et al. (2019)), prefer to forage in water less than 40 m in depth, and are not known to migrate, they are unlikely to co-occur in the offshore portion of the Study Area contemporaneously with Navy training and testing activities.

Inland Waters. There are confirmed sightings and movements of tagged sea otters in the eastern Strait of Juan de Fuca, around the San Juan Islands, and within the Puget Sound near Olympia (Calambokidis et al., 1987; Hale et al., 2019; Jeffries & Jameson, 2014; Lance et al., 2004; Sato, 2018). Sea otter surveys have not covered the Inland Waters east of Tongue Point; however, there have been confirmed sightings of scattered individuals in the San Juan Islands and Puget Sound. One sea otter was sighted about 9 km inland up McAllister Creek in south Puget Sound (Jeffries & Allen, 2001). More recently, a lone sea otter was reported in 2015 in south Puget Sound. No sea otter were sighted in the Strait of Juan de Fuca during the 2015 and 2016 survey, but a small group was sighted in the 2013 survey between Cape Flattery and Pillar Point (Jeffries & Jameson, 2014; Jeffries et al., 2016a, 2016b). Most of these sightings have been of one or two animals, with no sightings of multiple animals reported (Jeffries & Jameson, 2014; Sato, 2018). For purposes of the analysis in this Supplemental, sea otters in the Inland Waters area are unlikely to co-occur with Navy training and testing activities.

Western Behm Canal, Alaska. Based on surveys conducted in 2003 and 2010, there are common sightings in southeast Alaska along the western portions of Prince of Wales Islands and throughout the Chatham and Summer Strait. The closest sea otter populations, as determined by these surveys, are approximately 50 NM south of the Behm Canal SEAFAC area along the coast at Dixon Entrance (Esslinger & Bodkin, 2009; Tinker et al., 2019). As sea otters seldom range more than 2 km from shore and are not known to migrate, and given they are only presently known to occupy distinct spots along the Pacific Coast, they are unlikely to occur in the Behm Canal SEAFAC area where their presence would be considered extralimital.

3.4.2 Environmental Consequences

Under the Proposed Action for this Supplemental, there have been some modifications to the quantity and type of acoustic stressors under the two action alternatives. Because of new activities being proposed, two new stressors would be introduced that are analyzed for their potential effects on marine species: high-energy lasers (as an Energy stressor), as detailed in Section 3.0.3.3.2.2 (High-Energy Lasers), and biodegradable polymer (as an Entanglement stressor), as detailed in Section 3.0.3.5.3 (Biodegradable Polymer).

In the 2015 NWTT Final EIS/OEIS (U.S. Department of the Navy, 2015a), the Navy considered all potential stressors associated with ongoing training and testing in the Study Area and then analyzed their potential impacts on marine mammals in that area. In addition, NMFS also reviewed the Navy's analysis and detailed their findings with regard to requirements under the MMPA (National Oceanic and Atmospheric Administration, 2015b) and pursuant to the ESA for the Navy's Proposed Action in the Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2014).

In general, there have been no substantial changes to the overall conclusions reached regarding ESA-listed species or populations of marine mammals in the Study Area. Use of acoustic stressors (sonar and other transducers) and use of explosives have occurred since the 2015 completion of the NWTT Final EIS/OEIS Record of Decision, MMPA Authorization, and ESA Biological Opinion.

In this Supplemental, the Navy has reviewed the analysis of impacts from these ongoing activities and additionally analyzed the new or changing military readiness activities as projected into the reasonably foreseeable future. The projected future actions are based on evolving operational requirements, including those associated with any anticipated new platforms or systems not previously analyzed. The Navy has compiled, thoroughly reviewed, and incorporated, the best available emergent marine mammal science since 2015 that is relevant to the analysis of environmental impacts from the proposed activities as presented in the 2015 NWTT Final EIS/OEIS. Where there has been no substantive or otherwise meaningful change in the action, science, or regulations, the Navy will rely on the 2015 NWTT

Final EIS/OEIS analysis. Where there has been substantive change in the action, science, or regulations, the information provided in this analysis will supplement the 2015 NWTT Final EIS/OEIS to support environmental compliance with applicable environmental statutes for marine mammals (the MMPA and ESA) for the foreseeable future beginning in 2020.

The 2015 NWTT Final EIS/OEIS considered training and testing activities proposed to occur in the Study Area that may have the potential to result in the MMPA defined take of marine mammals or to affect ESA-listed marine mammal species. The stressors applicable to marine mammals in the Study Area for this Supplemental include the two new stressors and the same stressors considered in the 2015 NWTT Final EIS/OEIS:

- Acoustic (sonar and other transducers, vessel noise, aircraft noise, weapon noise)
- Explosives (in-air explosions, in-water explosions)
- Energy (in-water electromagnetic devices, high-energy lasers, radar)
- Physical disturbance and strike (vessels and in-water devices, military expended materials, seafloor devices)
- Entanglement (wires and cables, decelerators/parachutes, biodegradable polymer)
- Ingestion (military expended materials – munitions, military expended materials – other than munitions)
- Secondary (impacts on habitat, impacts on prey availability)

This section of this Supplemental evaluates how and to what degree potential impacts on marine mammals from stressors described in Section 3.0 (Introduction) may have changed since the analysis presented in the 2015 NWTT Final EIS/OEIS was completed. Tables 2.5-1, 2.5-2, and 2.5-3 in Chapter 2 (Description of Proposed Action and Alternatives) list the proposed training and testing activities and include the number of times each activity would be conducted annually and the locations within the Study Area where the activity would typically occur under each alternative. The tables also present the same information for activities described in the 2015 NWTT Final EIS/OEIS so that the proposed levels of training and testing under this Supplemental can be easily compared. The analysis in this Supplemental includes consideration of the Navy's standard operating procedures and mitigation that the Navy will implement to avoid or reduce potential impacts on marine mammals from acoustic, explosive, and physical disturbance and strike stressors. Mitigation for marine mammals was coordinated with NMFS through the MMPA and ESA consultation processes, and is detailed in Chapter 5 (Mitigation) and Appendix K (Geographic Mitigation Assessment) of this Supplemental EIS/OEIS.

In 2015, the Navy and NMFS determined that within the Study Area only acoustic stressors and explosive stressors could potentially result in harassment and/or the incidental taking of marine mammals from Navy training and testing activities (National Oceanic and Atmospheric Administration, 2015a, 2015b; U.S. Department of the Navy, 2015a) and that none of the other stressors would result in significant adverse impacts or jeopardize the continued existence of any ESA-listed marine mammals (National Marine Fisheries Service, 2014).

As detailed in Chapter 2 (Description of Proposed Action and Alternatives) of this Supplemental, there are no changes to proposed training and testing activities that would necessitate re-analysis of any of the activities associated with those stressors for which NMFS has previously determined did not rise to the level of a take under the MMPA. As presented in Section 3.0 (Introduction), since completion of the

NWTT Final EIS/OEIS in 2015 there have been refinements made in the modeling of potential impacts from sonar and other transducers and in-water explosives. These changes have been incorporated into the re-analysis of acoustic and explosive stressors presented in this Supplemental. In addition to the new effects criteria, weighting functions, and thresholds for multiple species, new information for marine mammals includes the integration of new marine mammal density data based on new predictive habitat modeling (Becker et al., 2020; Becker et al., 2017; Hazen et al., 2016; Mannocci et al., 2017; U.S. Department of the Navy, 2020), new survey data and analyses (Barlow, 2016; Dahlheim et al., 2015; Houghton et al., 2015a; Jefferson et al., 2017; Jefferson et al., 2016; Smultea et al., 2017), tagging data (Calambokidis et al., 2017a; DeLong et al., 2017; Hanson et al., 2018; Hanson et al., 2017; Mate et al., 2015a; Mate et al., 2017), and acoustic monitoring data (Emmons et al., 2019b; Rice et al., 2017; Trickey et al., 2015; Wiggins et al., 2019; Wiggins et al., 2017).

There have been no changes to the NWTT Study Area, existing conditions, species life histories, or any new information available since 2015 that the Navy believes would otherwise substantively change the conclusions[7] presented in the 2015 NWTT Final EIS/OEIS. What is new since 2015 are refinements to the Navy Acoustic Effects Model and marine mammal densities based on emergent science. This Supplemental, therefore, focuses on a re-analysis of potential impacts on marine mammals from acoustic stressors involving use of sonar and other transducers and the use of in-water explosives. The following paragraphs provide details on refinements to the Navy's acoustic modeling since 2015. Most important is the information found in Section 3.4.3.4 (Summary of Monitoring and Observations During Navy Activities Since 2015) regarding scientific data gathered on marine mammals in locations where Navy has been training and testing, which serves as an empirical basis for the marine mammal impact assessment presented in this Supplemental.

Over approximately the last decade and for multiple Navy range complexes, analyses have been undertaken for the same general Navy training and testing activities that are included in the Proposed Action (U.S. Department of the Navy, 2008, 2010, 2013c, 2015a, 2017a, 2018a, 2018b). In these prior analyses and based on the best available science and consultations with NMFS, the Navy determined that all other acoustic stressors used during training and testing at-sea, including weapons firing, launch, and impact noise; vessel noise; and aircraft noise, have had *de minimis*, discountable, insignificant, or negligible impacts, or no impacts. Since fewer activities are proposed in the NWTT Study Area than were proposed in the Southern California Range Complex (as well as other previously analyzed Navy range complexes), activities in the NWTT Study Area should result in fewer annual impacts on marine mammals than similar activities with similar stressors at the Southern California Range Complex. In all previous analyses, NMFS reviewed the Navy's analyses and conclusions regarding these stressors as they pertain to the MMPA and found them "complete and supportable," including the recent analysis for the Southern California Range Complex (83 FR 66849; December 27, 2018 and 84 FR 48388; September 13, 2019). The Navy has determined that acoustic stressors may affect ESA-listed marine mammals. With regard to the ESA and the same training and testing activities occurring in the NWTT Study Area, for the Southern California Range Complex NMFS has recently again determined that weapons firing, launch,

[7] Conclusions in this regard refer to the findings reached by Navy and NMFS on the two previous sets of analyses for the continuation of training and testing in Study Area and as recently re-considered by NMFS for many of the same actions elsewhere (FR 83[247]:66846-67031; December 27, 2018). Under the MMPA, the Navy and NMFS have found that there will not be negligible impacts to populations of marine mammals. Under ESA, the actions may affect certain ESA-listed marine mammal species, but are not likely to jeopardize the continued existence of those species.

and impact noise; vessel noise; and aircraft noise are discountable or insignificant and not likely to adversely affect ESA-listed species (National Marine Fisheries Service, 2018b).

The majority of the changes in the results of the impact analyses presented in this Supplemental pursuant to requirements of the MMPA and ESA arise from changes in the model input; specifically, more accurate marine mammal density data, revised acoustic impact criteria, and revised computer modeling of predicted effects on marine mammals. These improvements are described in Section 3.0.1.2 (Navy's Quantitative Analysis to Determine Impacts to Sea Turtles and Marine Mammals). Assessment of likely long-term consequences to populations of marine mammals are provided by empirical data gathered from areas where Navy routinely trains and tests. Substantial Navy-funded marine mammal survey data, monitoring data, and scientific research have been completed since 2006. These empirical data are beginning to provide insight on the qualitative analysis of the actual (as opposed to model predicted numerical) impact on marine mammals resulting from Navy training and testing activities based on observations of marine mammals generally in and around Navy Range Complexes. The following subsections of this Supplemental presents the potential environmental consequences based on an updated modeling methodology and the scientific observations and investigations made over 12 years of monitoring of Navy training and testing activities in the Pacific and elsewhere that are representative of the type of activities proposed in this Supplemental.

3.4.2.1 Acoustic Stressors

Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic sources, the marine mammals that may be present in the vicinity of the sources, and the effects that sound may have on the physiology and behavior of those marine mammals. Although it is known that sound is important for marine mammal communication, navigation, and foraging (National Research Council, 2003, 2005), there are many unknowns in assessing impacts such as the potential interaction of different effects and the significance of responses by marine mammals to sound exposures (Nowacek et al., 2007; Southall et al., 2007). Many other factors besides just the received level of sound may affect an animal's reaction such as the duration of the sound-producing activity, the animal's physical condition, prior experience with the sound, activity at the time of exposure (e.g., feeding, traveling, resting), the context of the exposure (e.g., in a semi-enclosed bay vs. open ocean), and proximity to the source of the sound.

The ways in which an acoustic exposure could result in immediate effects or long-term consequences for an animal are explained in Section 3.0.3.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities). The following Background section discusses what is currently known about acoustic effects to marine mammals. These effects could hypothetically extend from physical injury or trauma to a behavioral or stress response that may or may not be detectable. Injury (physical trauma) can occur to organs or tissues of an animal (Section 3.4.2.1.1.1, Injury). Hearing Loss (Section 3.4.2.1.1.2, Hearing Loss) is a noise-induced decrease in hearing sensitivity, which can be either temporary or permanent. Physiological stress (Section 3.4.2.1.1.3, Physiological Stress) is an adaptive process that helps an animal cope with changing conditions; however, too much stress can result in physiological effects. Masking (Section 3.4.2.1.1.4, Masking) can occur when the perception of a biologically important sound (i.e., signal) is interfered with by a second sound (i.e., noise). Behavioral response (Section 3.4.2.1.1.5, Behavioral Reactions) ranges from brief distractions to avoidance of a sound source to prolonged flight. Extreme behavioral or physiological responses can lead to stranding (Section 3.4.2.1.1.6, Stranding). Long-term consequences (Section 3.4.2.1.1.7, Long-Term Consequences) are those impacts, or accumulation of impacts, that can result in decreases in individual fitness or population changes. To avoid or reduce potential impacts to the maximum extent practicable, the Navy will implement marine mammal mitigation measures during applicable training and testing activities that generate acoustic stressors (see Chapter 5, Mitigation; and Appendix K, Geographic Mitigation Assessment).

The Navy will rely on the previous 2015 NWTT Final EIS/OEIS for the analysis of vessel noise, aircraft noise, and weapon noise, and new applicable and emergent science in regard to these sub-stressors is presented in the sections which follow. Due to new acoustic impact criteria, marine mammal densities, and revisions to the Navy Acoustic Effects Model, the analysis provided in Section 3.4.2.1.2 (Impacts from Sonar and Other Transducers) of this Supplemental supplants the 2015 NWTT Final EIS/OEIS for marine mammals and changes estimated impacts for some species since the 2015 NWTT Final EIS/OEIS.

3.4.2.1.1 Background

3.4.2.1.1.1 Injury

Injury (i.e., physical trauma) refers to the effects on the tissues or organs of an animal due to pressure waves. Injury due to non-explosive acoustic stressors such as sonar is discussed below. Moderate- to low-level sound sources, including vessel and aircraft noise, would not cause injury. Section 3.0.3.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities) provides additional information on injury (i.e., physical trauma) and the framework used to analyze this potential impact.

Several mechanisms of acoustically induced tissue damage (non-auditory) have been proposed and are discussed below.

Injury due to Sonar-Induced Acoustic Resonance

An object exposed to its resonant frequency will tend to amplify its vibration at that frequency, a phenomenon called acoustic resonance. Acoustic resonance has been proposed as a mechanism by which a sonar or sources with similar operating characteristics could damage tissues of marine mammals. In 2002, NMFS convened a panel of government and private scientists to investigate the potential for acoustic resonance to occur in marine mammals (National Oceanic and Atmospheric Administration, 2002). They modeled and evaluated the likelihood that Navy mid-frequency sonar caused resonance effects in beaked whales that eventually led to their stranding. The conclusions of the group were that resonance in air-filled structures was not likely to have caused the Bahamas stranding in 2000. The frequency at which resonance was predicted to occur in the animals’ lungs was 50 Hz, well below the frequencies used by the mid-frequency sonar systems associated with the Bahamas event. Furthermore, air cavity vibrations, even at resonant frequencies, were not considered to be of sufficient amplitude to cause tissue damage, even under the unrealistic scenario in which air volumes would be undamped (unrestrained) by surrounding tissues and the amplitude of the resonant response would be greatest. These same conclusions would apply to other training and testing activities involving acoustic sources. Therefore, the Navy concludes that acoustic resonance would not occur under real training conditions and testing activities. The potential impact of acoustic resonance is not considered further in this analysis.

Nitrogen Decompression

Marine mammals mitigate nitrogen gas accumulation in their blood and other tissues, which is caused exchange from the lungs under conditions of increased hydrostatic pressure during diving, through anatomical, behavioral, and physiological adaptations (Hooker et al., 2012).

Although not an injury caused by the interaction of sound with tissues, variations in marine mammal diving behavior or avoidance responses in response to sound exposure have been hypothesized to result in the off-gassing of nitrogen super-saturated tissues, possibly to the point of deleterious vascular and tissue bubble formation (Hooker et al., 2012; Jepson et al., 2003; Saunders et al., 2008) with resulting symptoms similar to decompression sickness (also known as “the bends”).

Whether marine mammals can produce deleterious gas emboli has been under debate in the scientific community (Hooker et al., 2012; Saunders et al., 2008), although various lines of evidence have been presented in support of the phenomenon. Some of these postulations are described below.

1. Analyses of bycaught animals demonstrated that nitrogen bubble formation occurs in drowned animals when they are brought to the surface (Bernaldo de Quiros et al., 2013b; Moore et al., 2009). Since gas exchange with the lungs no longer occurs once drowned, tissues become supersaturated with nitrogen due to the reduction in hydrostatic pressure near the surface. This demonstrates that the phenomenon of bubble formation is at least physically possible.
2. The presence of osteonecrosis (bone death due to reduced blood flow) in deep-diving sperm whales has been offered as evidence of impacts due to chronic nitrogen supersaturation and a lifetime of decompression insults (Moore & Early, 2004).
3. Dennison et al. (2012) investigated dolphins stranded in 2009–2010. Using ultrasound, they identified gas bubbles in kidneys of 21 of the 22 live-stranded dolphins and in the liver of two of the 22. The authors postulated that stranded animals were unable to recompress by diving, and thus retained bubbles that would have otherwise re-absorbed in animals that continued to dive. However, the researchers concluded that the minor bubble formation observed could be tolerated since the majority of stranded dolphins released did not re-strand.
4. A fat embolic syndrome (out of place fat particles, typically in the bloodstream) was identified by Fernández et al. (2005) coincident with the identification of bubble emboli in stranded beaked whales. The fat embolic syndrome was the first pathology of this type identified in marine mammals and was thought to possibly arise from the formation of bubbles in fat bodies, which subsequently resulted in the release of fat emboli into the blood stream.
5. Findings of gas and fat emboli in a few stranded Risso’s dolphin, and in which sonar exposure was ruled out as a cause of stranding, suggested that other factors, in this case struggling with a prey item, might cause significant variations in dive behavior such that emboli formation could occur (Fernandez et al., 2017).

Only one study has attempted to find vascular bubbles in a freely diving marine mammal (Houser et al., 2009). In that study, no vascular bubbles were imaged by ultrasound in a bottlenose dolphin that repeatedly dove to a 100 m depth and maintained a dive profile meant to maximize nitrogen gas uptake. Thus, although lines of evidence suggest that marine mammals manage excessive nitrogen gas loads, the majority of the evidence for the formation of bubble and fat emboli come from stranded animals in which physiological compromise due to the stranding event is a potential confounding factor.

Researchers have examined how dive behavior affects tissue supersaturation conditions that could put an animal at risk of gas bubble embolism. An early hypothesis was that if exposure to a startling sound elicits a rapid ascent to the surface, tissue gas saturation sufficient for the evolution of nitrogen bubbles might result (Fernandez et al., 2005; Jepson et al., 2003). However, modeling suggested that even unrealistically rapid rates of ascent from normal dive behaviors are unlikely to result in supersaturation to the extent that bubble formation would be expected in beaked whales (Zimmer & Tyack, 2007). Instead, emboli observed in animals exposed to mid-frequency active sonar (Fernandez et al., 2005; Jepson et al., 2003) could stem from a behavioral response that involves repeated dives, shallower than the depth of lung collapse (Aguilar de Soto et al., 2006; Hooker et al., 2012; Tyack et al., 2006; Zimmer & Tyack, 2007). Longer times spent diving at mid-depths above lung collapse would allow gas exchange from the lungs to continue under high hydrostatic pressure conditions, increasing potential for supersaturation; below the depth of lung collapse, gas exchange from the lungs to the blood would likely not occur (Costidis & Rommel, 2016; Fahlman et al., 2014b). To estimate risk of decompression sickness, Kvadsheim et al. (2012) modeled gas exchange in the tissues of sperm, pilot, killer, and beaked whales based on actual dive behavior during exposure to sonar in the wild. Results predicted that venous supersaturation would be within the normal range for these species, which would presumably have naturally higher levels of nitrogen gas loading. Nevertheless, deep-diving whales, such as beaked whales, have also been predicted to have higher nitrogen gas loads in body tissues for certain modeled changes in dive behavior, which might make them more susceptible to decompression sickness (Fahlman et al., 2014b; Fernandez et al., 2005; Hooker et al., 2012; Jepson et al., 2003). Bernaldo de Quiros et al. (2019) summarized discussions from a 2017 workshop on potential sonar impacts on beaked whales, suggesting that the effect of mid-frequency active sonar on beaked whales varies among individuals or populations and that predisposing conditions such as previous exposure to sonar and individual health risk factors may contribute to individual outcomes (such as decompression sickness) as well.

Modeling has suggested that the long, deep dives performed regularly by beaked whales over a lifetime could result in the saturation of long-halftime tissues (i.e., tissues that take longer to give off nitrogen, e.g., fat and bone lipid) to the point that they are supersaturated when the animals are at the surface (Fahlman et al., 2014b; Hooker et al., 2009; Saunders et al., 2008). Proposed adaptations for prevention of bubble formation under conditions of persistent tissue saturation have been suggested (Fahlman et al., 2006; Hooker et al., 2009), and because of the time it takes for tissue offloading, it is feasible that long-halftime tissues are not a concern for decompression insults under normal ventilation or dive (recompression) conditions. However, for beaked whale strandings associated with sonar use, one proposed hypothesis is that observed bubble formation may be caused by compromised blood flow due to stranding-related cardiovascular collapse. This would reduce the ability to remove nitrogen from tissues following rapid sonar-induced stranding and could preclude typical management of nitrogen in supersaturated, long-halftime tissues (Houser et al., 2009).

Predictive modeling conducted to date has been performed with many unknowns about the respiratory physiology of deep-diving breath-hold animals. For example, Denk et al. (2020) found intra-species differences in the compliance of tracheobronchial structures of post-mortem cetaceans and pinnipeds under diving hydrostatic pressures, which would affect depth of alveolar collapse. Although, as hypothesized by Garcia Parraga et al. (2018), mechanisms may exist that allow marine mammals to create a pulmonary shunt without the need for hydrostatic pressure-induced lung collapse, i.e., by varying perfusion to the lung independent of lung collapse and degree of ventilation. If such a mechanism exists, then assumptions in prior gas models require reconsideration, the degree of nitrogen gas accumulation associated with dive profiles needs to be re-evaluated, and behavioral responses potentially leading to a destabilization of the relationship between pulmonary ventilation and perfusion should be considered. Costidis and Rommel (2016) suggested that gas exchange may continue to occur across the tissues of air-filled sinuses in deep-diving odontocetes below the depth of lung collapse, if hydrostatic pressures are high enough to drive gas exchange across into non-capillary veins.

If feasible, kinetic gas models would need to consider an additional gas exchange route that might be functional at great depths within the odontocetes. Other adaptations potentially mitigating and defending against deleterious nitrogen gas emboli have been proposed (Blix et al., 2013). Researchers have also considered the accumulation of carbon dioxide produced during periods of high activity by an animal, theorizing that accumulating carbon dioxide, which cannot be removed by gas exchange below the depth of lung collapse, might also facilitate the formation of bubbles in nitrogen-saturated tissues (Bernaldo de Quiros et al., 2012; Fahlman et al., 2014b). In all of these cases, the hypotheses have received little in the way of experimentation to evaluate whether or not they are supported, thus leaving many unknowns as to the predictive accuracy of modeling efforts.

The appearance of extensive bubble and fat emboli in beaked whales was unique to a small number of strandings associated with certain high-intensity sonar events; the phenomenon has not been observed to the same degree in other stranded marine mammals, including other beaked whale strandings not associated with sonar use. It is uncertain as to whether there is some more easily-triggered mechanism for this phenomenon specific to beaked whales or whether the phenomenon occurs only following rapidly occurring stranding events (i.e., when whales are not capable of sufficiently decompressing). Nevertheless, based on the rarity of observations of bubble pathology, the potential for nitrogen decompression sickness, or "the bends," as a result of exposure to Navy sound sources is considered discountable.

Acoustically Induced Bubble Formation due to Sonars

A suggested cause of injury to marine mammals is rectified diffusion (Crum & Mao, 1996), the process of increasing the size of a microscopic gas bubble by exposing it to a sound field. The process is dependent upon a number of factors, including the sound pressure level (SPL) and duration. Under this hypothesis, microscopic bubbles assumed to exist in the tissues of marine mammals may experience one of three things: (1) bubbles grow to the extent they become emboli or cause localized tissue trauma, (2) bubbles develop to the extent that a complement immune response is triggered or the nervous tissue is subjected to enough localized pressure that pain or dysfunction occurs (a stress response without injury), or (3) the bubbles are cleared by the lung without negative consequence to the animal.

Rectified diffusion is facilitated if the environment in which the ensonified bubbles exist is supersaturated with gas. As discussed above, repetitive diving by marine mammals can cause the blood and some tissues to become supersaturated (Ridgway & Howard, 1979). The dive patterns of some marine mammals (e.g., beaked whales) are predicted to induce greater supersaturation (Houser et al., 2001). If rectified diffusion were possible in marine mammals exposed to high-level sound, conditions of tissue supersaturation could theoretically speed the rate and increase the size of bubble growth. Subsequent effects due to tissue trauma and emboli would presumably mirror those observed in humans suffering from decompression sickness.

It is unlikely that the short duration of sonar pulses would be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. However, an alternative but related hypothesis has also been suggested: stable microbubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of supersaturated tissues. In such a scenario, the marine mammal would need to be in a gas-supersaturated state for a long enough time for bubbles to become a problematic size. The phenomena of bubble growth due to a destabilizing exposure was shown by Crum et al. (2005) by exposing highly supersaturated ex vivo bovine tissues to a 37 kHz source at 214 dB re 1 µPa. Although bubble growth occurred under the extreme conditions created for the study, these conditions would not exist in the wild because the levels of tissue supersaturation in the study (as high as 400–700 percent) are substantially higher than model predictions for marine mammals (Fahlman et al., 2009; Fahlman et al., 2014b; Houser et al., 2001; Saunders et al., 2008), and such high exposure levels would only occur in very close proximity to the most powerful sonars. For these reasons, it is improbable that this mechanism is responsible for stranding events or traumas associated with beaked whale strandings.

There has been considerable disagreement among scientists as to the likelihood of this phenomenon (Evans & Miller, 2003; Piantadosi & Thalmann, 2004). Although it has been argued that traumas from beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Fernandez et al., 2005; Jepson et al., 2003), nitrogen bubble formation as the cause of the traumas has not been verified. The presence of bubbles postmortem, particularly after decompression, is not necessarily indicative of bubble pathology (Bernaldo de Quiros et al., 2012; Bernaldo de Quiros et al., 2013a; Bernaldo de Quiros et al., 2013b; Dennison et al., 2012; Moore et al., 2009), and other mechanisms by which bubble emboli might occur once animals are rapidly stranded (e.g., cardiovascular collapse preventing tissue off-gassing) have not been ruled out (Houser et al., 2009).

3.4.2.1.1.2 Hearing Loss

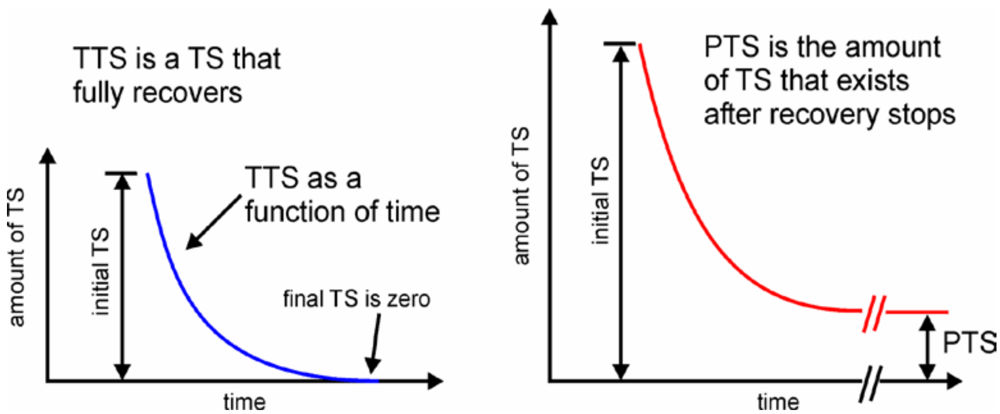
Exposure to intense sound may result in noise-induced hearing loss that persists after cessation of the noise exposure. The specific amount of hearing loss, and whether the loss is temporary or permanent, depend on factors such as the exposure frequency, received sound pressure level, temporal pattern, and duration. The frequencies affected by hearing loss will vary depending on the frequency of the fatiguing noise, with frequencies at and above the noise frequency most strongly affected. The amount of hearing loss is highly variable and depends on the species, individual, and contextual factors.

Section 3.0.3.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities) provides additional information on hearing loss and the framework used to analyze this potential impact. Hearing loss has only been studied in a few species of marine mammals, although hearing studies with terrestrial mammals are also informative.

Hearing loss is typically quantified in terms of threshold shift (TS)—the amount (in dB) that hearing thresholds at one or more specified frequencies are elevated, compared to their pre-exposure values, at some specific time after the noise exposure. The amount of TS measured usually decreases with increasing recovery time—the amount of time that has elapsed since a noise exposure. If the TS eventually returns to zero (i.e., the hearing threshold returns to the pre-exposure value), the TS is called a temporary threshold shift (TTS). If the TS does not completely recover (the threshold remains elevated compared to the pre-exposure value), the remaining TS is called a permanent threshold shift (PTS). Figure 3.4-4 shows two hypothetical TSs: one that completely recovers, a TTS, and one that does not completely recover, leaving some PTS. By definition, TTS is a function of the recovery time, therefore comparing the severity of noise exposures based on the amount of induced TTS can only be done if the recovery times are also taken into account. For example, a 20-dB TTS measured 24 hours post-exposure indicates a more hazardous exposure than one producing 20 dB of TTS measured only two minutes after exposure; if the TTS is 20 dB after 24 hours, the TTS measured after two minutes would have likely been much higher. Conversely, if 20 dB of TTS was measured after two minutes, the TTS measured after 24 hours would likely have been much smaller.

Studies have revealed that intense noise exposures may also cause auditory system injury that does not result in PTS (i.e., hearing thresholds return to normal after the exposure, but there is injury nonetheless). Kujawa and Liberman (2009) found that noise exposures sufficient to produce a TTS of

40 dB, measured 24 hours post-exposure using electro-physiological methods, resulted in acute loss of nerve terminals and delayed degeneration of the cochlear nerve in mice. Lin et al. (2011) found a similar result in guinea pigs, that a TTS in auditory evoked potential of up to approximately 50 dB, measured 24 hours post-exposure, resulted in neural degeneration. These studies demonstrate that PTS should not be used as the sole indicator of auditory injury, since exposures producing high levels of TTS (40–50 dB measured 24 hours after exposure)—but no PTS—may result in auditory injury.



Notes: TTS = Temporary Threshold Shift, TS = Threshold Shift, PTS = Permanent Threshold Shift

Figure 3.4-4: Two Hypothetical Threshold Shifts

There are no simple functional relationships between TTS and the occurrence of PTS or other auditory injury (e.g., neural degeneration). However, TTS and PTS are, by definition, mutually exclusive: an exposure that produces TTS cannot also produce PTS within the same frequency band in the same individual (Reichmuth et al., 2019); conversely, if an initial TS only partially recovers, resulting in some amount of PTS, the difference between the initial TS and the PTS is not called TTS. As TTS increases, the likelihood that additional exposure SPL or duration will result in PTS or other injury also increases (with the exception that researchers might not be able to observe graduate growth of TTS with increased SELs before onset of PTS (Reichmuth et al., 2019)). Exposure thresholds for the occurrence of PTS or other auditory injury can therefore be defined based on a specific amount of TTS; that is, we assume that any additional exposure may result in some PTS or other injury. The specific upper limit of TTS is based on experimental data showing amounts of TTS that have not resulted in PTS or injury. In other words, we do not need to know the exact functional relationship between TTS and PTS or other injury, we only need to know the upper limit for TTS before some PTS or injury is possible.

A variety of human and terrestrial mammal data indicate that TSs up to 40 dB may be induced without PTS, and that 40 dB is a reasonable upper limit for allowable TS to prevent PTS (e.g., Kryter et al., 1965; Miller et al., 1963; Ward, 1960; Ward et al., 1958; Ward et al., 1959). It is reasonable to assume the same relationship would hold for marine mammals, since there are many similarities between the inner ears of marine and terrestrial mammals, and experiments with marine mammals have revealed similarities to terrestrial mammals for features such as TTS, age-related hearing loss, drug-induced hearing loss, masking, and frequency selectivity (Finneran, 2015; Finneran et al., 2005a; Ketten, 2000). Therefore, we assume that sound exposures sufficient to produce 40 dB of TTS measured approximately four minutes after exposure represent the limit of a non-injurious exposure (i.e., higher level exposures have the potential to cause auditory injury). Exposures sufficient to produce a TTS of 40 dB, measured approximately four minutes after exposure, therefore represent the threshold for auditory injury. The predicted injury could consist of either hair cell damage/loss resulting in PTS or other auditory injury, such as the delayed neural degeneration identified by Kujawa and Liberman (2009) and Lin et al. (2011) that may not result in PTS.

Numerous studies have directly examined noise-induced hearing loss in marine mammals (see Finneran, 2015). In these studies, hearing thresholds were measured in marine mammals before and after exposure to intense sounds. The difference between the pre-exposure and post-exposure thresholds was then used to determine the amount of TTS at various post-exposure times. The major findings from these studies include the following:

- The method used to test hearing may affect the resulting amount of measured TTS, with neurophysiological (i.e., auditory evoked potential) measures producing larger amounts of TTS compared to psychophysical (i.e., behavioral) measures (Finneran, 2015; Finneran et al., 2007).
- The amount of TTS usually varies with the hearing test frequency. As the exposure SPL increases, the frequency at which the maximum TTS occurs also increases (Kastelein et al., 2020a; Kastelein et al., 2014a). For high level exposures, the maximum TTS typically occurs one-half to one octave above the exposure frequency (Finneran et al., 2007; Kastelein et al., 2020a; Kastelein et al., 2019d; Kastelein et al., 2019f; Mooney et al., 2009a; Nachtigall et al., 2004; Popov et al., 2013; Popov et al., 2011; Reichmuth et al., 2019; Schlundt et al., 2000). The overall spread of TTS from tonal exposures can therefore extend over a large frequency range (i.e., narrowband exposures can produce broadband [greater than one octave] TTS).
- The amount of TTS increases with exposure SPL and duration, and is correlated with sound exposure level (SEL), especially if the range of exposure durations is relatively small (Kastak et al., 2007; Kastelein et al., 2014a; Popov et al., 2014). As the exposure duration increases, however, the relationship between TTS and SEL begins to break down. Specifically, duration has a more significant effect on TTS than would be predicted on the basis of SEL alone (Finneran et al., 2010b; Kastak et al., 2005; Mooney et al., 2009a). This means if two exposures have the same SEL but different durations, the exposure with the longer duration (thus lower SPL) will tend to produce more TTS than the exposure with the higher SPL and shorter duration. In most acoustic impact assessments, the scenarios of interest involve shorter duration exposures than the marine mammal experimental data from which impact thresholds are derived; therefore, use of SEL tends to over-estimate the amount of TTS. Despite this, SEL continues to be used in many situations because it is relatively simple, more accurate than SPL alone, and lends itself easily to scenarios involving multiple exposures with different SPL.
- Gradual increases of TTS may not be directly observable with increasing exposure levels before the onset of PTS (Reichmuth et al., 2019). Similarly, PTS can occur without measurable behavioral modifications (Reichmuth et al., 2019).
- The amount of TTS depends on the exposure frequency. Sounds at low frequencies, well below the region of best sensitivity, are less hazardous than those at higher frequencies, near the region of best sensitivity (Finneran & Schlundt, 2013). The onset of TTS — defined as the exposure level at which a TS of 6 dB is measured approximately 4 minutes after exposure (i.e., clearly above the typical variation in threshold measurements) — also varies with exposure frequency. At low frequencies TTS onset exposure levels are higher compared to those in the region of best sensitivity. For example, for harbor porpoises exposed to one-sixth octave noise

bands at 16 kHz (Kastelein et al., 2019f), 32 kHz (Kastelein et al., 2019d), and 63 kHz (Kastelein et al., 2020a), less susceptibility to TTS was found as frequency increased, whereas exposure frequencies below around 6.5 kHz showed an increase in TTS susceptibility as frequency increased and approached the region of best sensitivity.

- TTS can accumulate across multiple exposures, but the resulting TTS will be less than the TTS from a single, continuous exposure with the same SEL (Finneran et al., 2010b; Kastelein et al., 2015b; Kastelein et al., 2014a; Mooney et al., 2009b). This means that TTS predictions based on the total, cumulative SEL will overestimate the amount of TTS from intermittent exposures such as sonars and impulsive sources.
- The amount of observed TTS tends to decrease with increasing time following the exposure; however, the relationship is not monotonic (i.e., increasing exposure does not always increase TTS). The time required for complete recovery of hearing depends on the magnitude of the initial shift; for relatively small shifts recovery may be complete in a few minutes, while large shifts (e.g., approximately 40 dB) may require several days for recovery. Recovery times are consistent for similar-magnitude shifts, regardless of the type of fatiguing sound exposure (impulsive, continuous noise band, or sinusoidal) (Kastelein et al., 2019e). Under many circumstances TTS recovers linearly with the logarithm of time (Finneran et al., 2010a, 2010b; Finneran & Schlundt, 2013; Kastelein et al., 2012a; Kastelein et al., 2012b; Kastelein et al., 2013a; Kastelein et al., 2014a; Kastelein et al., 2014b; Kastelein et al., 2014c; Popov et al., 2014; Popov et al., 2013; Popov et al., 2011). This means that for each doubling of recovery time, the amount of TTS will decrease by the same amount (e.g., 6 dB recovery per doubling of time).
- Several recent studies have shown that certain odontocete cetaceans (toothed whales) may learn to reduce their hearing sensitivity (presumably to protect their hearing) when warned of an impending intense sound exposure (Finneran, 2018; Nachtigall & Supin, 2013, 2014, 2015; Nachtigall et al., 2015; Nachtigall et al., 2016a, 2018; Nachtigall et al., 2016b). The effect was first demonstrated in a false killer whale (*Pseudorca crassidens*) by Nachtigall and Supin (2013). Subsequent experiments, using similar methods, demonstrated similar conditioned hearing changes in a bottlenose dolphin (Tursiops truncatus, Nachtigall & Supin, 2014; Nachtigall & Supin, 2015; Nachtigall et al., 2016b), beluga (Delphinapterus leucas, Nachtigall et al., 2015), and harbor porpoises (Phocoena phocoena, Nachtigall et al., 2016a). Using slightly different methods, Finneran (2018) measured the time course and frequency patterns of conditioned hearing changes in two dolphins. Based on these experimental measurements with captive odontocetes, it is likely that wild odontocetes would also suppress their hearing if they could anticipate an impending, intense sound, or during a prolonged exposure (even if not anticipated). Based on the time course and duration of the conditioned hearing reduction, odontocetes participating in some previous TTS experiments could have been protecting their hearing during exposures (Finneran, 2018). A better understanding of the mechanisms responsible for the observed hearing changes is needed for proper interpretation of some existing temporary TS data, particularly for considering TTS due to short duration, unpredictable exposures. No modification of analysis of auditory impacts is currently suggested, as the Phase III auditory impact thresholds are based on best available data for both impulsive and non-impulsive exposures to marine mammals.
- Due to the higher exposure levels or longer exposure durations required to induce hearing loss, only a few types of human-made sound sources have the potential to cause a TS to a marine

mammal in the wild. These include some sonars and other transducers and impulsive sound sources such as air guns and impact pile driving, neither of which will be used as part of training and testing activities being covered in this Supplement.

- Southall et al. (2019b) evaluated Southall et al. (2007) and used updated scientific information to propose revised noise exposure criteria to predict onset of auditory effects in marine mammals (i.e., PTS and TTS onset). Southall et al. (2019b) note that the quantitative processes described and the resulting exposure criteria (i.e., thresholds and auditory weighting functions) are largely identical to those in (U.S. Department of the Navy, 2017b) and NMFS (2016k, 2018a). However, they differ in that the Southall et al. (2019b) exposure criteria are more broadly applicable as they include all marine mammal species (rather than those only under NMFS jurisdiction) for all noise exposures (both in air and underwater for amphibious species), and, while the hearing group compositions are identical, they renamed the hearing groups. The thresholds discussed in the paper (TTS/PTS only) are the same as Navy's criteria and NMFS criteria.

Threshold Shift due to Sonars and Other Transducers

TTS in mid-frequency cetaceans exposed to non-impulsive sound has been investigated in multiple studies (Finneran et al., 2010a; Finneran et al., 2005b; Finneran & Schlundt, 2013; Mooney et al., 2009a; Mooney et al., 2009b; Nachtigall et al., 2003; Nachtigall et al., 2004; Popov et al., 2014; Popov et al., 2013; Schlundt et al., 2000) from two species, bottlenose dolphins and beluga whales. Two high-frequency cetacean species have been studied for TTS due to non-impulsive sources: the harbor porpoise (Kastelein et al., 2013a; Kastelein et al., 2015b; Kastelein et al., 2017a; Kastelein et al., 2014a; Kastelein et al., 2014b) and the finless porpoise (*Neophocaena phocaenoides*) (Popov et al., 2011). TTS from non-impulsive sounds has also been investigated in three pinniped species: harbor seal (*Phoca vitulina*), California sea lion (*Zalophus californianus*), and Northern elephant seal (*Mirounga angustirostris*) (e.g., Kastak et al., 2005; Kastelein et al., 2012a). These data are reviewed in detail in Finneran (2015) as well as the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* technical report (U.S. Department of the Navy, 2017b), and the major findings are summarized above.

Several studies of TS in marine mammals exposed to non-impulsive sounds have been published since development of the technical report. Kastelein et al. (2017a) examined TS in harbor porpoises (high-frequency cetaceans) exposed to 3.5–4.1 kHz sonar playbacks. Small amounts of TTS (5–6 dB) were observed after exposures with cumulative, weighted SELs of ~156–162 dB SEL, (~3–9 dB above the TTS onset threshold). The data are therefore consistent with the Phase III thresholds. Popov et al. (2017) measured auditory evoked potentials (AEPs) at 45 kHz in a beluga (a mid-frequency cetacean) before and after 10-minute exposure to half-octave noise centered at 32 kHz with SPL 170 dB re 1 µPa (weighted SEL = 198 decibels referenced to 1 micropascal squared seconds [dB re 1 $\mu Pa^2 s$]). After exposure, AEP amplitude vs. stimulus SPL functions were shifted to the right, but returned to baseline values over time. Maximum TS was 23–25 dB, 5 minutes post-exposure. For these exposures, Phase III criteria over-estimate the observed effects (i.e., Phase III criteria predict 40 dB of TTS for SEL of 198 dB re 1 $\mu Pa^2 s$).

Kastelein et al. (2019b) measured behavioral hearing thresholds for simulated sonar signals (helicopter long range active sonar, or HELRAS, at 1.3 - 1.4 kHz) in two captive harbor seals. Thresholds reported in this study (mean of 51 dB re 1 µPa) are slightly lower than those observed in a prior study of harbor seal behavioral hearing thresholds for tones (Kastelein et al., 2009). The authors suggest this small difference may be due to characteristics of the HELRAS signal (duration and/or harmonics) or changes in the test animals' performance over time. The data in this study would not affect the conclusions for acoustic impacts to marine mammals.

Additionally, Kastelein et al. (2019e) exposed two captive harbor seals to 6.5 kHz continuous, sinusoidal sound for 1 hour in water, resulting in a cumulative SEL between 159 and 195 dB re 1 $\mu Pa^2 s$, then measured TTS using behavioral hearing thresholds. The highest TTSs were produced in the one-half octave band above the exposure frequency, but individual seals showed variation in the magnitude of TTS produced. Both seals recovered within 1–2 hours for up to 6 dB of TS. One seal showed 19 dB of TTS after a 195 dB re 1 $\mu Pa^2 s$ exposure and recovered within 24 hours. Similarly, Kastelein et al. (2020b) exposed the same seals to 32 kHz, continuous, band-limited noise for 1 hour resulting in a cumulative SEL between 128 – 188 dB re 1 $\mu Pa^2 s$, and measured less than 6 dB of TS at 32 kHz which recovered within 1 hour. At a post-exposure test frequency of 45 kHz (a half-octave above the exposure frequency), the maximum TTS observed in this study were after a ~188 and ~191 dB re 1 $\mu Pa^2 s$ exposure, which resulted in approximately 34 and 45 dB of TTS, respectively. Recovery occurred over 4 days for both TTSs. Recovery was gradual for the 34-dB shift, but recovery from the 45-dB shift was not observed until between 4 and 24 hours post-exposure. No TTS was observed at a test frequency of 63 kHz for any sound exposure level. Overall, these studies combined with previous work showed that for harbor seals, times to recovery are consistent for similar-magnitude TTS, regardless of the type of sound exposure (impulsive, continuous noise band, or sinusoidal) (Kastelein et al., 2020b). However, recovery patterns may be less gradual for higher-magnitude TTS (above 45 dB). Overall, this study combined with previous work showed that for harbor seals, recovery times are consistent for similar-magnitude TTS, regardless of the type of sound exposure (impulsive, continuous noise band, or sinusoidal).

A longitudinal study tracked the hearing of a single harbor seal over more than ten years (Reichmuth et al., 2019). The harbor seal was originally exposed to a 4.1 kHz tone, which increased incrementally in SPL and duration over time, and was tested at 5.8 kHz. No reliable TTS was observed until the harbor seal was exposed to 60 s of the tone at 181 dB re 1 μPa, which resulted in a large TS (> 47 dB). The harbor seal's hearing at 4.1 kHz recovered within two days, but his hearing at one-half (5.8 kHz) and one (8.2 kHz) octave above the frequency of the noise resulted in PTS (8-11 dB) for over 10 and 2 years, respectively. This study contradicts common assumptions about the relationship of TTS and PTS: there was no gradual growth of TTS with increased levels of SEL before onset of PTS, and there were no behavioral fluctuations to indicate that damage to hair cells had occurred. As a result, researchers might not be able to observe gradual TTS with increasing exposure levels, and it is possible for permanent hearing damage to occur without measurable behavioral changes.

Threshold Shift due to Impulsive Sound Sources

Cetacean TTS data from impulsive sources are limited to two studies with measured TTS of 6 dB or more. Finneran et al. (2002) reported behaviorally measured TTSs of 6 and 7 dB in a beluga exposed to single impulses from a seismic water gun and Lucke et al. (2009) reported auditory evoked potential-measured TTS of 7–20 dB in a harbor porpoise exposed to single impulses from a seismic air gun.

In addition to these studies, a number of impulsive noise exposure studies have been conducted without behaviorally measurable TTS of 6 dB or more. The results of these studies are either consistent with the Navy Phase III criteria and thresholds (e.g., exposure levels were below those predicted to cause TTS and

TTS did not occur) or suggest that the Phase III thresholds over-estimate the potential for impact (e.g., exposure levels were above Navy Phase III TTS threshold, but TTS did not occur). The individual studies are summarized below:

Finneran et al. (2000) exposed dolphins and belugas to single impulses from an "explosion simulator" and Finneran et al. (2015) exposed three dolphins to sequences of 10 impulses from a seismic air gun (maximum cumulative SEL = 193 to 195 dB re 1 µPa^2s, peak SPL = 196 to 210 dB re 1 µPa) without measurable TTS. Finneran et al. (2003b) exposed two sea lions to single impulses from an arc-gap transducer with no measurable TTS (maximum unweighted SEL = 163 dB re 1 µPa^2s, peak SPL = 183 dB re 1 µPa).

Kastelein et al. (2015a) behaviorally measured mean TTS of 4 dB at 8 kHz and 2 dB at 4 kHz after a harbor porpoise was exposed to simulated impact pile driving sound. The cumulative SEL was approximately 180 dB re 1 µPa^2s (weighted SEL ~144 dB re 1 µPa^2s, 4 dB above the TTS onset threshold). Using similar, simulated pile driving noise, but varying total exposure duration from 15 to 360 min, Kastelein et al. (2016) found only small amounts of TTS (< 6 dB) in two harbor porpoises. The maximum weighted, cumulative SEL was 156 dB SEL (16 dB above Phase III threshold), but resulted in only ~5 dB of TTS.

Reichmuth et al. (2016) measured behavioral hearing thresholds in two spotted seals and two ringed seals before/after exposure to single air gun impulses and found no TTS. The maximum weighted SEL was ~156 dB re 1 uPa^2s (14 dB below TTS-onset) and the maximum p-p SPL was ~204 dB re 1 µPa (~8 dB below TTS onset).

Kastelein et al. (2017c) measured TTS in a harbor porpoise after exposure to multiple air gun impulses. Either a single or double air gun arrangement was used. Maximum exposure peak pressure was 194/199 dB re 1 µPa for single/double air guns. Maximum cumulative, weighted SEL was 127/130 dB re 1 µPa^2s. Maximum TTS occurred at 4 kHz and was 3 dB/4 dB for single/double air guns.

Kastelein et al. (2018a) measured TTS in two harbor seals after exposure to playbacks of impact pile-driving recordings. The maximum weighted cumulative SEL is estimated to be ~182 dB re 1 µPa^2s (~12 dB above Navy Phase III threshold). Maximum peak pressure is estimated to be 176 dB re 1 µPa, ~36 dB below the Navy Phase III threshold. Small amounts (4 dB maximum) of TTS were observed at 4 kHz after the maximum exposure. Use of Navy Phase III criteria and thresholds would have over-estimated measured effects.

3.4.2.1.1.3 Physiological Stress

The growing field of conservation physiology relies in part on the ability to monitor stress hormones in populations of animals, particularly those that are threatened or endangered. The ability to make predictions from stress hormones about impacts on individuals and populations exposed to various forms of stressors, natural and human-caused, relies on understanding the linkages between changes in stress hormones and resulting physiological impacts. At this time, the sound characteristics that correlate with specific stress responses in marine mammals are poorly understood, as are the ultimate consequences due to these changes. Navy-funded efforts are underway to try to improve the understanding of and the ability to predict how stressors ultimately affect marine mammal populations (e.g., King et al., 2015; New et al., 2013a; Pirotta et al., 2015a). With respect to acoustically induced stress, this includes not only determining how and to what degree various types of anthropogenic sound cause stress in marine mammals, but what factors can mitigate those responses. Factors potentially affecting an animal's response to a stressor include the mammal's life history stage, sex, age, reproductive status, overall physiological and behavioral plasticity, and whether they are naïve or experienced with the sound (e.g., prior experience with a stressor may result in a reduced response due to habituation (Finneran & Branstetter, 2013; St. Aubin & Dierauf, 2001). Because there are many unknowns regarding the occurrence of acoustically induced stress responses in marine mammals, the Navy assumes in its effect analysis that any physiological response (e.g., hearing loss or injury) or significant behavioral response is also associated with a stress response.

Marine mammals naturally experience stressors within their environment and as part of their life histories. Changing weather and ocean conditions, exposure to disease and naturally occurring toxins, lack of prey availability, and interactions with predators all contribute to the stress a marine mammal experiences (Atkinson et al., 2015). Breeding cycles, periods of fasting, social interactions with members of the same species, and molting (for pinnipeds) are also stressors, although they are natural components of an animal's life history. Anthropogenic activities have the potential to provide additional stressors beyond those that occur naturally (Fair et al., 2014; Meissner et al., 2015; Rolland et al., 2012). Anthropogenic stressors potentially include such things as fishery interactions, pollution, tourism, and ocean noise.

The stress response is a suite of physiological changes that are meant to help an organism mitigate the impact of a stressor (Moberg & Mench, 2000). Over short periods (i.e., hours/days), stress responses can provide access to energetic resources that can be beneficial in life-threatening situations. However, if the magnitude and duration of the stress response is too great or too long, then it can have negative consequences to the organism (e.g., decreased immune function, decreased reproduction). The generalized stress response is classically characterized by the release of cortisol, a hormone that has many functions including elevation of blood sugar, suppression of the immune system, and alteration of the biochemical pathways that affect fat, protein, and carbohydrate metabolism. However, it is now known that the endocrine response (glandular secretions of hormones into the blood) to a stressor can extend to other hormones. For instance, thyroid hormones can also vary under the influence of certain stressors, particularly food deprivation. These types of responses typically occur on the order of minutes to days. The "fight or flight" response, an acute stress response, is characterized by the very rapid release of hormones that stimulate glucose release, increase heart rate, and increase oxygen consumption. Chronic stressors can occur over the course of weeks or months. Rolland et al. (2017) compared acute (death by ship strike) to chronic (entanglement or live-stranding) stressors in North Atlantic right whales, and found that whales subject to chronic stressors had higher levels of glucocorticoid stress hormones (cortisol and corticosterone) than either healthy whales or those killed by ships. Authors presume that whales subject to acute stress here may have died too quickly for increases in fecal glucocorticoids to be detected.

What is known about the function of the various stress hormones is based largely upon observations of the stress response in terrestrial mammals. The endocrine response of marine mammals to stress may not be the same as that of terrestrial mammals because of the selective pressures marine mammals faced during their evolution in an ocean environment (Atkinson et al., 2015). For example, due to the necessity of breath-holding while diving and foraging at depth, the physiological role of epinephrine and norepinephrine (the catecholamines) might be different in marine versus other mammals. Catecholamines increase during breath-hold diving in seals, co-occurring with a reduction in heart rate, peripheral vasoconstriction (constriction of blood vessels), and an increased reliance on anaerobic metabolism during extended dives (Hance et al., 1982; Hochachka et al., 1995; Hurford et al., 1996); the catecholamine increase is not associated with an increased heart rate, glycemic release, and increased oxygen consumption typical of terrestrial mammals. Other hormone functions may also be different, such as aldosterone, which has been speculated to not only contribute to electrolyte balance, but possibly also the maintenance of blood pressure during periods of vasoconstriction (Houser et al., 2011). In marine mammals, aldosterone is thought to play a particular role in stress mediation because of its noted response to handling stress (St. Aubin & Dierauf, 2001; St. Aubin & Geraci, 1989).

Relatively little information exists on the linkage between anthropogenic sound exposure and stress in marine mammals, and even less information exists on the ultimate consequences of sound-induced stress responses (either acute or chronic). Most studies to date have focused on acute responses to sound either by measuring catecholamines or by measuring heart rate as an assumed proxy for an acute stress response. Belugas demonstrated no catecholamine response to the playback of oil drilling sounds (Thomas et al., 1990b) but showed a small but statistically significant increase in catecholamines following exposure to impulsive sounds produced from a seismic water gun (Romano et al., 2004). A bottlenose dolphin exposed to the same seismic water gun signals did not demonstrate a catecholamine response, but did demonstrate a statistically significant elevation in aldosterone (Romano et al., 2004), albeit the increase was within the normal daily variation observed in this species (St. Aubin et al., 1996) and was likely of little biological significance with respect to mitigating stress. Increases in heart rate were observed in bottlenose dolphins to which known calls of other dolphins were played, although no increase in heart rate was observed when background tank noise was played back (Miksis et al., 2001). Unfortunately, in this study, it cannot be determined whether the increase in heart rate was due to stress or an anticipation of being reunited with the dolphin to which the vocalization belonged. Similarly, a young beluga's heart rate was observed to increase during exposure to noise, with increases dependent upon the frequency band of noise and duration of exposure, and with a sharp decrease to normal or below normal levels upon cessation of the exposure (Lyamin et al., 2011). Spectral analysis of heart rate variability corroborated direct measures of heart rate (Bakhchina et al., 2017). This response might have been in part due to the conditions during testing, the young age of the animal, and the novelty of the exposure; a year later the exposure was repeated at a slightly higher received level and there was no heart rate response, indicating the beluga whale had potentially habituated to the noise exposure. Kvadsheim et al. (2010a) measured the heart rate of captive hooded seals during exposure to sonar signals and found an increase in the heart rate of the seals during exposure periods versus control periods when the animals were at the surface. When the animals dove, the normal dive-related bradycardia (decrease in heart rate) was not impacted by the sonar exposure. Similarly, Thompson et al. (1998) observed a rapid but short-lived decrease in heart rates in harbor and grey seals exposed to seismic air guns (cited in Gordon et al., 2003). Williams et al. (2017) recently monitored the heart rates of narwhals released from capture and found that a profound dive bradycardia persisted, even though exercise effort increased dramatically as part of their escape response following release. Thus, although some limited evidence suggests that tachycardia might occur as part of the acute stress response of animals that are at the surface, the bradycardia typical of diving in marine mammals appears to be dominant to any stress-related tachycardia and might even be enhanced in response to an acute stressor. Houser et al. (2020) measured cortisol and epinephrine obtained from 30 bottlenose dolphins exposed to simulated U.S. Navy mid-frequency sonar, and found no correlation between sound pressure level and stress hormone levels. In the same experiment (Houser et al., 2013b), behavioral responses were shown to increase in severity with increasing received sound pressure levels. These results suggest that behavioral reactions to sonar signals are not necessarily indicative of a hormonal stress response.

Whereas a limited amount of work has addressed the potential for acute sound exposures to produce a stress response, almost nothing is known about how chronic exposure to acoustic stressors affects stress hormones in marine mammals, particularly as it relates to survival or reproduction. In what is probably the only study of chronic noise exposure in marine mammals associating changes in a stress hormone with changes in anthropogenic noise, Rolland et al. (2012) compared the levels of cortisol metabolites in North Atlantic right whale feces collected before and after September 11, 2001. Following the events of September 11, shipping was significantly reduced in the region where fecal collections were made, and regional ocean background noise declined. Fecal cortisol metabolites significantly decreased during the period of reduced ship traffic and ocean noise (Rolland et al., 2012). Considerably more work has been conducted in an attempt to determine the potential effect of boating on smaller cetaceans, particularly killer whales (Bain, 2002; Erbe, 2002; Lusseau, 2006; Noren et al., 2009; Pirotta et al., 2015b; Read et al., 2014; Rolland et al., 2012; Williams et al., 2009; Williams et al., 2014b; Williams et al., 2014c; Williams et al., 2006). Most of these efforts focused primarily on estimates of metabolic costs associated with altered behavior or inferred consequences of boat presence and noise, but did not directly measure stress hormones. However, Ayres et al. (2012) investigated Southern Resident killer whale fecal thyroid hormone and cortisol metabolites to assess two potential threats to the species' recovery: lack of prey (salmon) and impacts from exposure to the physical presence of vessel traffic (but without measuring vessel traffic noise). Ayres et al. (2012) concluded from these stress hormone measures that the lack of prey overshadowed any population-level physiological impacts on Southern Resident killer whales due to vessel traffic. Collectively, these studies indicate the difficulty in teasing out factors that are dominant in exerting influence on the secretion of stress hormones, including the separate and additive effects of vessel presence and vessel noise. Nevertheless, although the reduced presence of the ships themselves cannot be ruled out as potentially contributing to the reduction in fecal cortisol metabolites in North Atlantic right whales, and there are potential issues in pseudoreplication and study design, the work of Rolland et al. (2012) represents the most provocative link between ocean noise and cortisol in cetaceans to date.

Navy-funded efforts are underway to try and improve our understanding and ability to predict how stressors ultimately affect marine mammal populations (e.g., King et al., 2015; New et al., 2013a; Pirotta et al., 2015a), and to determine whether a marine mammal being naïve or experienced with the sound (e.g., prior experience with a stressor) may result in a reduced response due to habituation (St. Aubin & Dierauf, 2001).

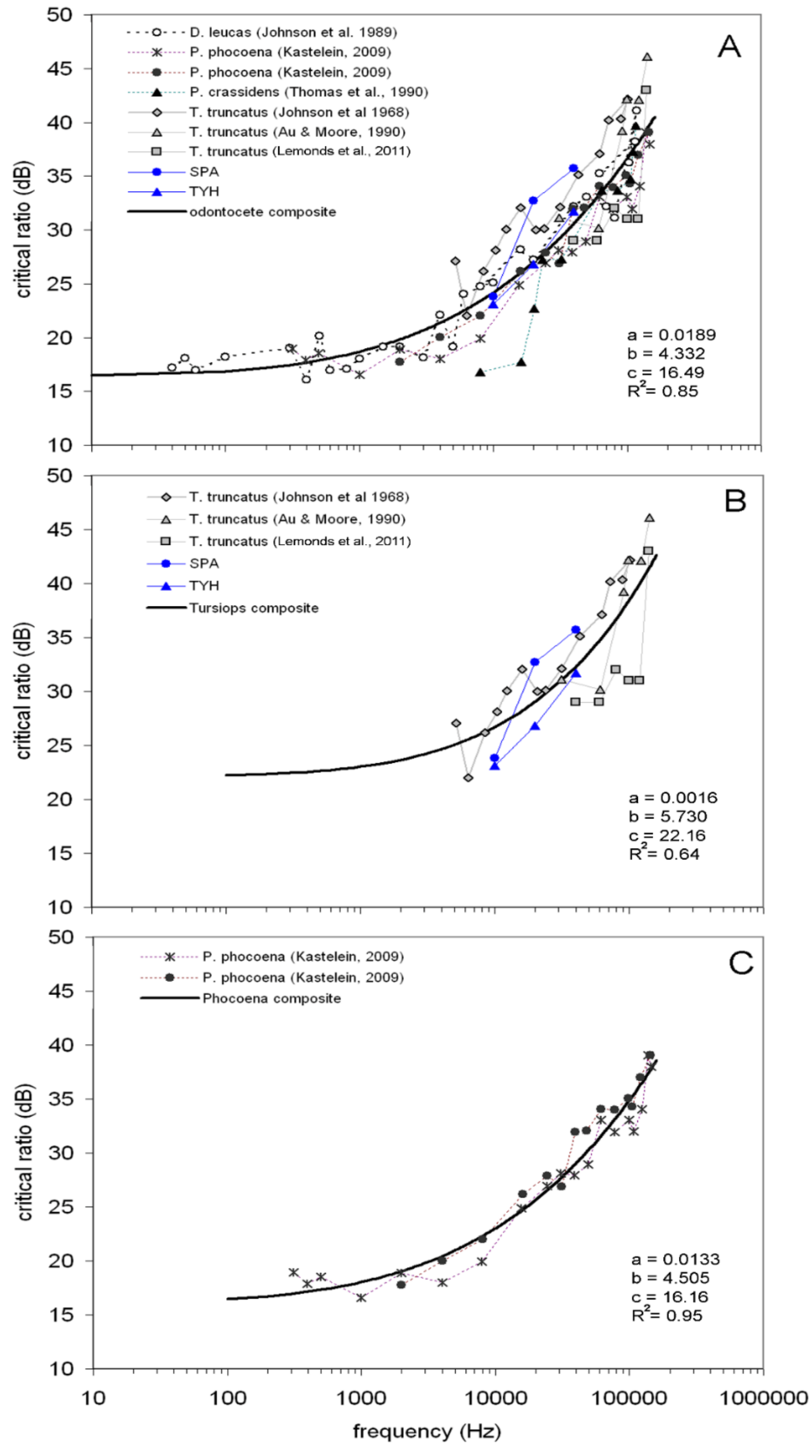
3.4.2.1.1.4 Masking

Masking occurs when one sound (i.e., noise) interferes with the detection, discrimination, or recognition of another sound (i.e., signal). The quantitative definition of masking is the amount in dB an auditory detection, discrimination, or recognition threshold is raised in the presence of a masker (Erbe et al., 2016). As discussed in Section 3.0.3.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities), masking can effectively limit the distance over which a marine mammal can communicate, detect biologically relevant sounds, and echolocate (odontocetes). Masking only occurs in the presence of the masking noise and does not persist after the cessation of the noise (with the potential exception of reverberations from impulsive noise). Masking can lead to vocal changes such as the Lombard effect (increasing amplitude), or other noise-induced vocal modifications such as changing frequency (Hotchkin & Parks, 2013), and behavioral changes (e.g., cessation of foraging, leaving an area) to both signalers and receivers, in an attempt to compensate for noise levels (Erbe et al., 2016).

Critical ratios are the lowest signal-to-noise ratio in which detection under masking conditions occurs (Finneran & Branstetter, 2013; Johnson et al., 1989; Southall et al., 2000). When expressed in dB, critical ratios can easily be calculated by subtracting the noise level (in dB re 1 $\mu Pa^2/Hz$) from the signal level (in dB re 1 µPa) at threshold. Critical ratios have been measured for pinnipeds (Southall et al., 2000, 2003), odontocetes (Au & Moore, 1990; Branstetter et al., 2017b; Johnson et al., 1989; Kastelein & Wensveen, 2008; Lemonds et al., 2011; Thomas et al., 1990a), and sea otters (Ghoul & Reichmuth, 2014b). Critical ratios increase as a function of signal frequency (Au & Moore, 1990; Lemonds et al., 2011). Higher frequency noise is more effective at masking higher frequency signals. Composite critical ratio functions have been estimated for odontocetes (Figure 3.4-5), which allow predictions of masking if the spectral density of noise is known (Branstetter et al., 2017b). Although critical ratios are typically estimated in controlled laboratory conditions using Gaussian (white) noise, critical ratios can vary considerably (Figure 3.4-6) depending on the noise type (Branstetter et al., 2013; Trickey et al., 2010). Signal type (e.g., whistles, burst-pulse, sonar clicks) and spectral characteristics (e.g., frequency modulation and/or harmonics) may further influence masked detection thresholds (Branstetter et al., 2016; Branstetter & Finneran, 2008; Branstetter et al., 2013; Cunningham et al., 2014).

Clark et al. (2009) developed a model for estimating masking effects on communication signals for low-frequency cetaceans, including calculating the cumulative impact of multiple noise sources. For example, the model estimates that a right whale’s optimal communication space (around 20 km) is decreased by 84 percent when two commercial ships pass through it. Similarly, Aguilar de Soto et al. (2006) found that a 15 dB increase in background noise due to vessels led to a communication range of only 18 percent of its normal value for foraging beaked whales. This method relies on empirical data on source levels of calls (which is unknown for many species) and requires many assumptions such as pre-industrial ambient noise conditions and simplifications of animal hearing and behavior, but it is an important step in determining the impact of anthropogenic noise on animal communication. Erbe (2016) developed a model with a noise source-centered view of masking to examine how a call may be masked from a receiver by a noise as a function of caller, receiver, and noise-source location, distance relative to each other, and received level of the call.

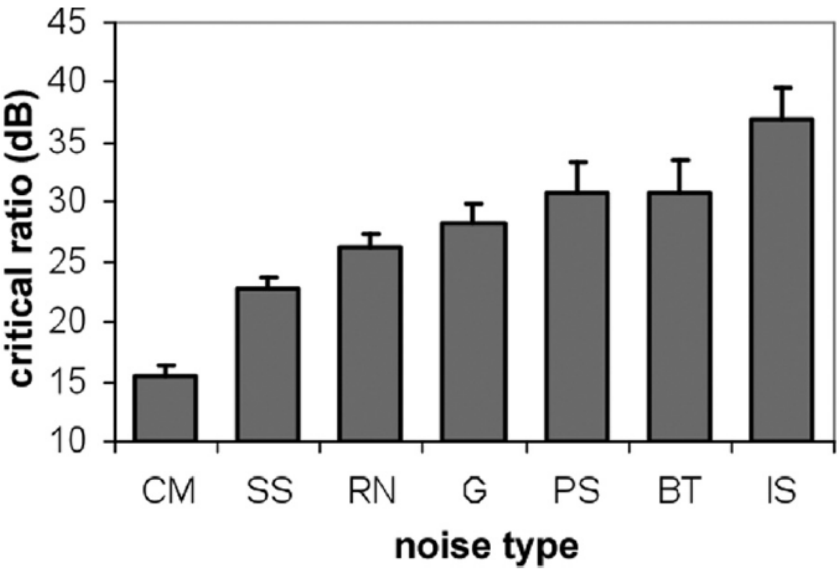
Vocal changes in response to anthropogenic noise can occur across the repertoire of sound production modes used by marine mammals, such as whistling, echolocation click production, calling, and singing. Vocalization changes include increasing the source level, modifying the frequency, increasing the call repetition rate of vocalizations, or ceasing to vocalize in the presence of increased noise (Hotchkin & Parks, 2013). In cetaceans, vocalization changes were reported from exposure to anthropogenic noise sources such as sonar, vessel noise, and seismic surveying (Gordon et al., 2003; Holt et al., 2011; Holt et al., 2008; Lesage et al., 1999; McDonald et al., 2009; Rolland et al., 2012) as well as changes in the natural acoustic environment (Caruso et al., 2020; Dunlop et al., 2014; Helble et al., 2020). Vocal changes can be temporary, or can be persistent, as seen in the increase in starting frequency for the North Atlantic right whale upcall over the last 50 years (Tennessen & Parks, 2016). Model simulation suggests that the frequency shift resulted in increased detection ranges between right whales; the frequency shift, coupled with an increase in call intensity by 20 dB, led to a call detectability range of less than 3 km to over 9 km (Tennessen & Parks, 2016). In some cases, these vocal changes may have fitness consequences, such as an increase in metabolic rates and oxygen consumption, as was found for bottlenose dolphins when increasing their call amplitude (Holt et al., 2015). A switch from vocal communication to physical, surface-generated sounds such as pectoral fin slapping or breaching was observed for humpback whales in the presence of increasing natural background noise levels, indicating that adaptations to masking may not be limited to vocal modifications (Dunlop et al., 2010). These changes all represent possible tactics by the sound-producing animal to reduce the impact of masking.



Source: Branstetter et al. (2017b)

Notes: (1) Odontocete critical ratios and composite model: CR = $a[\log_{10}(f)]^b + c$, where *a, b,* and *c* are model coefficients and *f* is the signal frequency in Hz. Equation 1 was fit to aggregate data for all odontocetes. (2) *T. truncatus.* critical ratios and composite model. (3) *P. phocoena.* critical ratios and composite model. Parameter values for composite models are displayed in the lower right of each panel.

Figure 3.4-5: Odontocete Critical Ratios



Source: Branstetter et al. (2013)
Notes: CM = comodulated, SS = snapping shrimp, RN = rain noise, G = Gaussian, PS = pile saw, BT = boat engine noise, and IS = ice squeaks

Figure 3.4-6: Critical Ratios for Different Noise Types

The receiving animal can also reduce masking by using active listening strategies such as orienting to the sound source, moving to a quieter location, or reducing self-noise from hydrodynamic flow by remaining still.

Spatial Release from Masking

Spatial release from masking (SRM) will occur when a noise and signal are separated in space, resulting in a reduction or elimination of masking (Holt & Schusterman, 2007; Popov et al., 2020). The relative position of sound sources can act as one of the most salient cues that allow the listener to segregate multiple sounds in a complex auditory scene. Many sounds are emitted from a directional source that is spatially separated from biologically relevant signals. Under such conditions, minimal masking will occur, and existing models of auditory masking will overestimate the amount of actual masking. Marine mammals have excellent sound source localization capabilities (Branstetter & Mercado, 2006; Byl et al., 2019; Renaud & Popper, 1975) and a directional receiving beam pattern (see Section 3.5.1.2 Hearing and Vocalization), which likely combine to aid in separating auditory events, thus improving detection performance.

Spatial release from masking has been empirically demonstrated using behavioral methods in a harbor seal and a California sea lion for 1, 8, and 16 kHz tones in air (Holt & Schusterman, 2007), where maximal SRM was 19 and 12 dB for each species respectively. Byl et al. (2019) used psychophysical methods to test the horizontal underwater sound-localization acuity of harbor seals for two noise bands (8–16 kHz and 14–16 kHz). When compared to sound-localization results for tonal stimuli in the same subjects (Byl et al., 2019), these results show better sound localization for stimuli with more spectral information.

Popov et al. (2020) measured the AEP in a single bottlenose dolphin and observed 32 dB of masking when there was no separation between a 64 kHz signal and noise presented directly in front of the animal. Spatial release from masking occurred when the masker was moved 30 degrees or more off-axis; but smaller angular separations between signal and noise were not tested. Approximately 16–24 dB of SRM was observed, but thresholds did not return to baseline even when the masker was 90 degrees to the left or right of center. While these results are pertinent, some of the brain structures that produce the AEP receive information from both ears, which might reduce the ability of this method (as opposed to behavioral methods) to fully describe spatial release from masking.

Informational Masking

Much emphasis has been placed on signal detection in noise and, as a result, most masking studies and communication space models have focused on masked detection thresholds. However, from a fitness perspective, signal detection is almost meaningless without the ability to determine the sound source location and recognize "what" is producing the sound. Marine mammals use sound to recognize conspecifics, prey, predators, or other biologically significant sources (Branstetter et al., 2016). Masked recognition thresholds (often called informational masking) for whistle-like sounds, have been measured for bottlenose dolphins (Branstetter et al., 2016) and are approximately 4 dB above detection thresholds (energetic masking) for the same signals. It should be noted that the term "threshold" typically refers to the listener's ability to detect or recognize a signal 50 percent of the time. For example, human speech communication, where only 50 percent of the words are recognized, would result in poor communication (Branstetter et al., 2016). Likewise, recognition of a conspecific call or the acoustic signature of a predator at only the 50 percent level could have severe negative impacts. If "quality communication" is arbitrarily set at 90 percent recognition (which may be more appropriately related to animal fitness), the output of communication space models (which are based on 50 percent detection) would likely result in a significant decrease in communication range (Branstetter et al., 2016).

Marine mammals use sound to recognize predators (Allen et al., 2014; Cummings & Thompson, 1971; Curé et al., 2015; Fish & Vania, 1971). Auditory recognition may be reduced in the presence of a masking noise, particularly if it occurs in the same frequency band. Therefore, the occurrence of masking may prevent marine mammals from responding to the acoustic cues produced by their predators. Whether this is a possibility depends on the duration of the masking and the likelihood of encountering a predator during the time that detection and recognition of predator cues are impeded. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by mammal-eating killer whales. The seals acoustically discriminate between the calls of mammal-eating and fish-eating killer whales (Deecke et al., 2002), a capability that should increase survivorship while reducing the energy required to attend to all killer whale calls. Similarly, sperm whales (Curé et al., 2016; Isojunno et al., 2016), long-finned pilot whales (Visser et al., 2016), and humpback whales (Curé et al., 2015) changed their behavior in response to killer whale vocalization playbacks; these findings indicating that some recognition of predator cues could be missed if the killer whale vocalizations were masked.

Masking by Sonar and Other Transducers

Masking only occurs in the presence of the masking noise and does not persist after the cessation of the noise. Because traditional military sonars typically have low duty cycles, relatively short duration, and narrow bandwidth that does not overlap with vocalizations for most marine mammal species, the effects of such masking would be limited when compared with continuous sources (e.g., vessel noise). Dolphin whistles and mid-frequency active sonar are similar in frequency, so masking is possible but less likely due to the low-duty cycle of most sonars. Low-frequency active sonar could also overlap with mysticete vocalizations (e.g., minke and humpback whales). For example, in the presence of low-frequency active sonar, humpback whales were observed to increase the length of their songs (Fristrup et al., 2003; Miller et al., 2000), possibly due to the overlap in frequencies between the whale song and the low-frequency active sonar.

Newer high-duty cycle or continuous active sonars have more potential to mask vocalizations, particularly for delphinids and other mid-frequency cetaceans. These sonars transmit more frequently (greater than 80 percent duty cycle) than traditional sonars, but at a substantially lower source level. Similarly, high-frequency acoustic sources such as pingers that operate at higher repetition rates (e.g., 2–10 kHz with harmonics up to 19 kHz, 76 to 77 pings per minute (Culik et al., 2001), also operate at lower source levels. While the lower source levels limit the range of impact compared to traditional systems, animals close to the sonar source are likely to experience masking on a much longer time scale than those exposed to traditional sonars. The frequency range at which high-duty cycle systems operate overlaps the vocalization frequency of many mid-frequency cetaceans. Continuous noise at the same frequency of communicative vocalizations may cause disruptions to communication, social interactions, and acoustically mediated cooperative behaviors such as foraging or reproductive activities. Similarly, because the systems are mid-frequency, there is the potential for the sonar signals to mask important environmental cues like predator vocalizations (e.g., killer whales), possibly affecting survivorship for targeted animals. While there are currently no available studies of the impacts of high-duty cycle sonars on marine mammals, masking due to these systems is likely analogous to masking produced by other continuous sources (e.g., vessel noise and low-frequency cetaceans), and will likely have similar short-term consequences, though longer in duration due to the duration of the masking noise. These may include changes to vocalization amplitude and frequency (Brumm & Slabbekoorn, 2005; Hotchkin & Parks, 2013) and behavioral impacts such as avoidance of the area and interruptions to foraging or other essential behaviors (Gordon et al., 2003). Long-term consequences could include changes to vocal behavior and vocalization structure (Foote et al., 2004; Parks et al., 2007), abandonment of habitat if masking occurs frequently enough to significantly impair communication (Brumm & Slabbekoorn, 2005), a potential decrease in survivorship if predator vocalizations are masked (Brumm & Slabbekoorn, 2005), and a potential decrease in recruitment if masking interferes with reproductive activities or mother-calf communication (Gordon et al., 2003).

Masking by Vessel Noise

Masking is more likely to occur in the presence of broadband, relatively continuous noise sources such as vessels. For example, right whales were observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise (Parks et al., 2007) as well as increasing the amplitude (intensity) of their calls (Parks, 2009; Parks et al., 2011). Right whales also had their communication space reduced by up to 84 percent in the presence of vessels (Clark et al., 2009). Cholewiak et al. (2018) found that right whale gunshot calls had the lowest loss of communication space in Stellwagen National Sanctuary (5 percent), while fin and humpback whales lost up to 99 percent of their communication space with increased ambient noise and shipping noise combined. Although humpback whales off Australia did not change the frequency or duration of their vocalizations in the presence of ship noise, their source levels were lower than expected based on source level changes to wind noise, potentially indicating some signal masking (Dunlop, 2016). Vessel noise decreased the 4 km of humpback whale modeled communication space (with wind noise up to 100 dB re 1 µPa) to 3 km at the same received level, and at 105 dB re 1 µPa of noise communication space decreased again to 2 km for low-frequency signals and 1 km for high-frequency signals (Dunlop, 2019). Communication space loss due to vessels in Glacier Bay National Park was estimated to be lower for singing humpback whales than for calling whales and was highest for roaring harbor seals, but synchronizing the arrival and departure times of ships into the park restored some of that communication space for the calling whales and seals (Gabriele et al., 2018). Fournet et al. (2018) found humpback whales increase their call source levels by 0.8 dB and decrease the probability of calling by 9 percent for every 1 dB increase in ambient sound, which included vessel noise.

Multiple delphinid species have also been shown to increase the minimum or maximum frequencies of their whistles in the presence of anthropogenic noise (Papale et al., 2015). More specifically, Williams et al. (2014b) found that in median noise conditions in Haro Strait, killer whales lose 62 percent of their acoustic communication space in the frequency band of their social calls (1.5–3.5 kHz) out to 8 km due to vessel traffic noise, and in peak traffic hours lose up to 97 percent of that space; however, when looking at a smaller area or higher frequency bands, less communication space is lost. In fact, at the higher frequency band of their echolocation clicks (18–30 kHz), no communication space was lost out to 2 km. Holt et al. (2011; 2008) showed that Southern Resident killer whales in the waters surrounding the San Juan Islands increased their call source level as vessel noise increased. In the presence of boats off the Southern end of Vancouver, Southern Resident killer whales changed the duration of 16 out of 21 discrete call types (Wieland et al., 2010). Most of those call types (n=14) increased mean duration, while 2 call types decreased in duration. Hermannsen et al. (2014) estimated that broadband vessel noise could extend up to 160 kHz at ranges from 60 to 1,200 m, and that the higher frequency portion of that noise might mask harbor porpoise clicks. However, this may not be an issue as harbor porpoises may avoid vessels and may not be close enough to have their clicks masked (Dyndo et al., 2015; Polacheck & Thorpe, 1990; Sairanen, 2014). Furthermore, Hermannsen et al. (2014) estimated that a 6 dB elevation in noise would decrease the hearing range of a harbor porpoise by 50 percent, and a 20 dB increase in noise would decrease the hearing range by 90 percent. Gervaise et al. (2012) estimated that beluga whales in the St. Lawrence Marine Park had their communication space reduced to 30 percent during average vessel traffic. During peak traffic, communication space was further reduced to 15 percent. Lesage et al. (1999) found belugas in the St. Lawrence River estuary reduced overall call rates but increased the production of certain call types when ferry and small outboard motor boats were approaching. Furthermore, these belugas increased the vocalization frequency band when vessels were in close proximity. Liu et al. (2017) found that broadband shipping noise could cause masking of humpback dolphin whistles within 1.5–3 km, and masking of echolocation clicks within 0.5–1.5 km.

Masking by Impulsive Sound

Potential masking from weapon noise is likely to be similar to masking studied for other impulsive sounds such as air guns. Masking could occur in mysticetes due to the overlap between their low-frequency vocalizations and the dominant frequencies of impulsive sources, however, masking in odontocetes or pinnipeds is less likely unless the activity is in close range when the pulses are more broadband. For example, differential vocal responses in marine mammals were documented in the presence of seismic survey noise. An overall decrease in vocalizations during active surveying was noted in large marine mammal groups (Potter et al., 2007), while blue whale feeding/social calls increased when seismic exploration was underway (Di Lorio & Clark, 2010), indicative of a possible compensatory response to the increased noise level. Furthermore, in the presence of biological interference from conspecific echolocation clicks (i.e., sonar jamming), cetaceans exhibit compensatory behaviors. Kloepper and Branstetter (2019) showed that individual bottlenose dolphins responded to jamming signals by omitting clicks (i.e., utilized a temporal response) or increasing click bandwidth (i.e., utilized a spectral response). Bowhead whales were found to increase call rates in the presence of seismic air gun noise at lower received levels (below 100 dB re 1 μPa^2s cumulative SEL), but once the received level rose above 127 dB re 1 μPa^{2}s cumulative SEL the call rate began decreasing, and stopped altogether once received levels reached 170 dB re 1 μPa^{2}s cumulative SEL (Blackwell et al., 2015). Nieukirk et al. (2012) recorded both seismic surveys and fin whale 20 Hz calls at various locations around the mid-Atlantic Ocean, and hypothesized that distant seismic noise could mask those calls thereby decreasing the communication range of fin whales, whose vocalizations may propagate over 400 km to reach conspecifics (Spiesberger & Fristrup, 1990). Two captive seals (one spotted and one ringed) were exposed to seismic air gun sounds recorded within 1 km and 30 km of an air gun survey conducted in shallow (<40 m) water. They were then tested on their ability to detect a 500-millisecond upsweep centered at 100 Hz at different points in the air gun pulse (start, middle, and end). Based on these results, a 100 Hz vocalization with a source level of 130 dB re 1 μPa would not be detected above a seismic survey 1 km away unless the animal was within 1–5 m, and would not be detected above a survey 30 km away beyond 46 m (Sills et al., 2017).

3.4.2.1.1.5 Behavioral Reactions

As discussed in Section 3.0.3.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities), any stimulus in the environment can cause a behavioral response in marine mammals. These stimuli include noise from anthropogenic sources such as vessels, sonar, or aircraft, but could also include the physical presence of a vessel or aircraft. However, stimuli such as the presence of predators, prey, or conspecifics could also influence how or if a marine mammal responds to a sound. Furthermore, the response of a marine mammal to an anthropogenic sound may depend on the frequency, duration, temporal pattern and amplitude of the sound as well as the animal's prior experience with the sound and their behavioral state (i.e., what the animal is doing and their energetic needs at the time of the exposure) (Ellison et al., 2011). The distance from the sound source and whether it is 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. (1995b). Other reviews (Nowacek et al., 2007; Southall et al., 2007) addressed studies conducted since 1995 and focused on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated, and also examined the role of context. Southall et al. (2007) synthesized data from many past behavioral studies and observations to determine the likelihood of behavioral reactions at specific sound levels, and Southall et al. (2016b) reviewed the range of experimental field studies that have been conducted to measure behavioral responses of cetaceans to sonar. 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; Southall et al., 2016a). Ellison et al. (2011) outlined an approach to assessing the effects of sound on marine mammals that incorporates these contextual-based factors. They recommend considering not just the received level of sound, but also in what activity the animal is engaged, the nature and novelty of the sound (i.e., is this a new sound from the animal's perspective), and the distance between the sound source and the animal. They submit that this "exposure context," as described, greatly influences the type of behavioral response exhibited by the animal (see technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017b)). Forney et al. (2017) also point out that an apparent lack of response (e.g., no displacement or avoidance of a sound source) may not necessarily mean there is no cost to the individual or population, as some resources or habitats may be of such high value that animals may choose to stay, even when experiencing stress or hearing loss. Forney et al. (2017) recommend considering both the costs of remaining in an area of noise exposure such as TTS, PTS, or masking, which could lead to an increased risk of predation or other threats or a decreased capability to forage, and the costs of displacement, including potential increased risk of vessel strike or bycatch, increased risks of predation or competition for resources, or decreased habitat suitable for foraging, resting, or socializing.

Behavioral reactions could result from a variety of sound sources such as sonar and other transducers (e.g., pingers), vessel noise, and aircraft noise. There is data on the reactions of some species in different behavioral states, providing evidence on the importance of context in gauging a behavioral response. However, for most species, little or no data exist on behavioral responses to any sound source, and so all species have been grouped into broad taxonomic groups from which general response information can be inferred (see technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017b)).

Behavioral Reactions to Sonar and Other Transducers

Sonar and other transducers can range in frequency from less than 1 kHz (e.g., low-frequency active sonar) to over 200 kHz (e.g., fish finders), with duty cycles that range from one ping per minute to an almost continuous sound. Although very high-frequency sonars are out of the hearing range of most marine mammals, some of these sources may contain artifacts at lower frequencies that could be detected (Deng et al., 2014; Hastie et al., 2014). High-duty cycle sonar systems operate at lower source levels, but with a more continuous sound output. These sources can be stationary, or on a moving platform, and there can be more than one source present at a time. Guan et al. (2017) also found that sound levels in the mid-frequency sonar bandwidth remained elevated at least 5 dB above background levels for the first 7–15 seconds (within 2 km) after the emission of a sonar ping; depending on the length of the sonar ping and the inter-ping interval, this reverberation could increase cumulative SEL estimates during periods of active sonar. This variability in parameters associated with sonar and other transducers makes the estimation of behavioral responses to these sources difficult, with observed responses ranging from no apparent change in behavior to more severe responses that could lead to some costs to the animal. As discussed in Section 3.0.3.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities) and Section 3.4.2.1.1.5 (Behavioral Reactions), responses may also occur in the presence of different contextual factors regardless of received level, including the proximity and number of vessels, the behavioral state and prior experience of an individual, and even characteristics of the signal itself or the propagation of the signal through the environment.

In order to explore this complex question, behavioral response studies have been conducted through the collaboration of various research and government organizations in Bahamian, United States (off Southern California), Mediterranean, Australian, and Norwegian waters. These studies have attempted to define and measure responses of beaked whales and other cetaceans to controlled exposures of sonar and other sounds to understand better their potential impacts. While controlling for as many variables as possible (e.g., the distance and movement of the source), these studies also introduce additional variables that do not normally occur in a real Navy training or testing activity, including the tagging of whales, following the tagged animals with multiple vessels, and continually approaching the animal to create a dose escalation. In addition, distances of the sound source from the whales during behavioral response studies were always within 1–8 km. Some of these studies have suggested that ramping up a source from a lower source level would act as a mitigation measure to protect against higher order (e.g., TTS or PTS) impacts of some active sonar sources; however, this practice may only be effective for more responsive animals, and for short durations (e.g., 5 minutes) of ramp-up (von Benda-Beckmann et al., 2014; von Benda-Beckmann et al., 2016; Wensveen et al., 2017).

Therefore, while these studies have provided the most information to date on behavioral responses of marine mammals to sonar, there are still many contextual factors to be teased apart, and determining what might produce a significant behavioral response is not a trivial task. Additional information about active sonar ramp-up procedures, including why the Navy will not implement them as mitigation under the Proposed Action, is provided in Section 5.5.1 (Active Sonar).

Passive acoustic monitoring and visual observational behavioral response studies have also been conducted on Navy ranges, taking advantage of the existing seafloor hydrophones and real testing and training activity and associated sources to assess behavioral responses (Deakos & Richlen, 2015; Henderson et al., 2016; Manzano-Roth et al., 2016; Martin et al., 2015; McCarthy et al., 2011; Mobley & Deakos, 2015; Moretti et al., 2014; Tyack et al., 2011). In addition, extensive aerial, visual, and passive acoustic monitoring have been conducted before, during, and after training events to watch for behavioral responses during training and look for injured or stranded animals after training (Falcone et al., 2017; Farak et al., 2011; Henderson et al., 2016; Manzano-Roth et al., 2016; Mobley, 2011; Norris et al., 2012a; Norris et al., 2012b; Smultea & Mobley, 2009; Smultea et al., 2009; Trickey et al., 2015; U.S. Department of the Navy, 2011b, 2013b, 2014b, 2015b). During all of these monitoring efforts, very few behavioral responses were observed, and no injured or dead animal was observed that was directly related to a training event (some dead animals were observed but typically before the event or appeared to have been deceased prior to the event; e.g., Smultea et al., 2011). While passive acoustic studies are limited to observations of vocally active marine mammals, and visual studies are limited to what can be observed at the surface, these study types have the benefit of occurring in the absence of some of the added contextual variables in the controlled exposure studies. Furthermore, when visual and passive acoustic data collected during a training event are combined with ship movements and sonar use, and with tagged animal data when possible, they provide a unique and realistic scenario for analysis, as in Falcone et al. (2017), Manzano-Roth et al. (2016), or Baird et al. (2017). In addition to these types of observational behavioral response studies, Harris and Thomas (2015) highlighted additional research approaches that may provide further information on behavioral responses to sonars and other transducers beyond behavior response type studies or passive acoustic monitoring, including conducting controlled exposures on captive animals with scaled (smaller sized and deployed at closer proximity) sources, on wild animals with both scaled and real but directed sources, and predator playback studies, all of which will be discussed below.

The above behavioral response studies and observations have been conducted on a number of mysticete and odontocete species, which can be extrapolated to other similar species in these taxonomic groups. No field studies of pinniped behavioral responses to sonar have been conducted; however, there are several captive studies on some pinniped and odontocete species that can provide insight into how these animals may respond in the wild. The captive studies typically represent a more controlled approach, which allow researchers to better estimate the direct impact of the received level of sound leading to behavioral responses, and to potentially link behavioral to physiological responses. However, there are still contextual factors that must be acknowledged, including previous training to complete tasks and the presence of food rewards upon completion. There are no corresponding captive studies on mysticete whales; therefore, some of the responses to higher-level exposures must be extrapolated from odontocetes.

Mysticetes

The responses of mysticetes to sonar and other duty-cycled tonal sounds are highly dependent upon the characteristics of the signal, the behavioral state of the animal, the particular sensitivity and previous experience of an individual, and other contextual factors including distance of the source, movement of the source, and the physical presence of vessels in addition to the sonar (Goldbogen et al., 2013; Harris et al., 2015; Martin et al., 2015; Sivle et al., 2015). Behavioral response studies have been conducted over a variety of contextual and behavioral states, helping to identify which contextual factors may lead to a response beyond just the received level of the sound. Observed reactions during behavioral response studies have not been consistent across individuals based on received sound levels alone, and likely were the result of complex interactions between these contextual factors.

Surface feeding blue whales did not show a change in behavior in response to mid-frequency simulated and real sonar sources with received levels between 90 and 179 dB re 1 µPa, but deep feeding and non-feeding whales showed temporary reactions including cessation of feeding, reduced initiation of deep foraging dives, generalized avoidance responses, and changes to dive behavior. The behavioral responses they observed were generally brief, of low to moderate severity, and highly dependent on exposure context (behavioral state, source-to-whale horizontal range, and prey availability) (DeRuiter et al., 2017; Goldbogen et al., 2013; Sivle et al., 2015; Southall et al., 2019b). Similarly, while the rates of foraging lunges decreased in humpback whales due to sonar exposure, there was variability in the response across individuals, with one animal ceasing to forage completely and another animal starting to forage during the exposure (Sivle et al., 2016). In addition, lunges decreased (although not significantly) during a no-sonar control vessel approach prior to the sonar exposure, and lunges decreased less during a second sonar approach than during the initial approach, possibly indicating some response to the vessel and some habituation to the sonar and vessel after repeated approaches. In the same experiment, most of the non-foraging humpback whales did not respond to any of the approaches (Sivle et al., 2016). These humpback whales also showed variable avoidance responses, with some animals avoiding the sonar vessel during the first exposure but not the second, while others avoided the sonar during the second exposure, and only one avoided both. In addition, almost half of the animals that avoided were foraging before the exposure but the others were not; the animals that avoided while not feeding responded at a slightly lower received level and greater distance than those that were feeding (Wensveen et al., 2017). These findings indicate that the behavioral state of the animal plays a role in the type and severity of a behavioral response. In fact, when the prey field was mapped and used as a covariate in similar models looking for a response in the same blue whales, the response in deep-feeding behavior by blue whales was even more apparent, reinforcing the need for contextual variables to be included when assessing behavioral responses (Friedlaender et al., 2016). Further, it was found that the probability of a moderate behavioral response increased when the range to source was closer for these foraging blue whales, although there was a high degree of uncertainty in that relationship (Southall et al., 2019b).However, even when responses did occur the animals quickly returned to their previous behavior after the sound exposure ended (Goldbogen et al., 2013; Sivle et al., 2015). In another study, humpback whales exposed to a 3 kHz pinger meant to act as a net alarm to prevent entanglement did not respond or change course, even when within 500 m (Harcourt et al., 2014). However, five out of six North Atlantic right whales exposed to an acoustic alarm interrupted their foraging dives; in this case, the alarm was comprised of a mixture of signals with frequencies from 500 to 4500 Hz, was long in duration (lasting several minutes), and was purposely designed to elicit a reaction from the animals as a prospective means to protect them from ship strikes (Nowacek et al., 2004). Although the animals' received SPL was similar in the latter two studies (133–150 dB re 1 $\mu Pa^2 s$), the frequency, duration, and temporal pattern of signal presentation were different. Harris et al. (2019a) suggest that differences in responses between species may be due to contextual factors such as location, time of year, sound source characteristics, or exposure context through the comparison of differences in changes in lunge feeding between blue, fin, and humpback whales observed during sonar controlled exposure experiments.

Humpback whales in another behavioral response experiment in Australia also responded to a 2 kHz tone stimulus by changing their course during migration to move more offshore and surfaced more frequently, but otherwise did not respond (Dunlop et al., 2013). Humpback whales in the Norwegian behavioral response study may have habituated slightly between the first and second sonar exposure (Sivle et al., 2015), and actually responded more severely to killer whale vocalization playbacks than they did to the sonar playbacks. Several humpback whales have been observed during aerial or visual surveys during Navy training events involving sonar; no avoidance or other behavioral responses were ever noted, even when the whales were observed within 5 km of a vessel with active (or possibly active) sonar and maximum received levels were estimated to be between 135 and 161 dB re 1 µPa (Mobley, 2011; Mobley & Milette, 2010; Mobley & Pacini, 2012; Mobley et al., 2012; Smultea et al., 2009). In fact, one group of humpback whales approached a vessel with active sonar so closely that the sonar was shut down and the vessel slowed; the animals continued approaching and swam under the bow of the vessel (U.S. Department of the Navy, 2011a). Another group of humpback whales continued heading towards a vessel with active sonar as the vessel was moving away for almost 30 minutes, with an estimated median received level of 143 dB re 1 µPa. This group was observed producing surface active behaviors such as pec slaps, tail slaps, and breaches; however, these are very common behaviors in competitive pods during the breeding season and were not considered to have occurred in response to the sonar (Mobley et al., 2012). In addition, Henderson et al. (2019) examined the dive and movement behavior of humpback whales tagged at the U.S. Navy's Pacific Missile Range Facility, including whales incidentally exposed to sonar during Navy training activities. Tracking data showed that individual humpbacks spent limited time, no more than a few days, in the vicinity of Kaua'i. Potential behavioral responses to sonar exposure were limited and may have been influenced by engagement in breeding and social behaviors.

The strongest baleen whale response in any behavioral response study was observed in a minke whale in the 3S2 study, which responded at 146 dB re 1 µPa by strongly avoiding the sound source (Kvadsheim et al., 2017; Sivle et al., 2015). Although the minke whale increased its swim speed, directional movement, and respiration rate, none of these were greater than rates observed in baseline behavior, and its dive behavior remained similar to baseline dives. A minke whale tagged in the Southern California behavioral response study also responded by increasing its directional movement, but maintained its speed and dive patterns, and so did not demonstrate as strong of a response (Kvadsheim et al., 2017). In addition, the 3S2 minke whale demonstrated some of the same avoidance behavior during the controlled ship approach with no sonar, indicating at least some of the response was to the vessel (Kvadsheim et al., 2017). Martin et al. (2015) found that the density of calling minke whales was reduced during periods of Navy training involving sonar relative to the periods before training, and increased again in the days after training was completed. The responses of individual whales could not be assessed, so in this case it is unknown whether the decrease in calling animals indicated that the animals left the range, or simply ceased calling. Similarly, minke whale detections made using Marine Acoustic Recording Instruments off Jacksonville, FL, were reduced or ceased altogether during periods of sonar use (Norris et al., 2012b; U.S. Department of the Navy, 2013b), especially with an increased ping rate (Charif et al., 2015). Harris et al. (2019b) utilized acoustically generated minke whale tracks at the U.S. Navy's Pacific Missile Range Facility to statistically demonstrate changes in the spatial distribution of minke whale acoustic presence Before, During, and After surface ship mid-frequency active sonar training. The spatial distribution of probability of acoustic presence was different in the During phase compared to the Before phase, and the probability of presence at the center of ship activity for the

During phase was close to zero for both years. The After phases for both years retained lower probabilities of presence suggesting the return to baseline conditions may take more than five days. The results show a clear spatial redistribution of calling minke whales during surface ship mid-frequency active sonar training, however a limitation of passive acoustic monitoring is that one cannot conclude if the whales moved away, went silent, or a combination of the two. Two minke whales also stranded in shallow water after the U.S. Navy training event in the Bahamas in 2000, although these animals were successfully returned to deep water with no physical examinations; therefore, no final conclusions were drawn on whether the sonar led to their stranding (Filadelfo et al., 2009a; Filadelfo et al., 2009b; U.S. Department of Commerce & U.S. Department of the Navy, 2001).

Baleen whales have also been exposed to lower and much higher frequency sonars, with the hypothesis that these whales may react more strongly to lower frequency sounds that overlap with their vocalization range. One series of studies was undertaken in 1997–1998 pursuant to the Navy's Low-Frequency Sound Scientific Research Program. The frequency bands of the low-frequency sonars used were between 100 and 500 Hz, with received levels between 115 and 150 dB re 1 µPa, and the source was always stationary. Fin and blue whales were targeted on foraging grounds, singing humpback whales were exposed on breeding grounds, and gray whales were exposed during migratory behavior. These studies found only short-term responses to low-frequency sound by some fin and humpback whales, including changes in vocal activity and avoidance of the source vessel, while other fin, humpback, and blue whales did not respond at all. When the source was in the path of migrating gray whales they changed course up to 2 km to avoid the sound, but when the source was outside their path, little response was observed although received levels were similar (Clark & Fristrup, 2001; Croll et al., 2001; Fristrup et al., 2003; Miller et al., 2000; Nowacek et al., 2007). Low-frequency signals of the Acoustic Thermometry of Ocean Climate sound source were also not found to affect dive times of humpback whales in Hawaiian waters (Frankel & Clark, 2000). Frankel and Stein (2020) exposed migrating gray whales to moored-source IMAPS sonar transmissions in the 21–25 kHz frequency band (estimated RL = 148 dB re 1 μPa^2) and showed that whales changed their path and moved closer to the shore when the vessel range was 1–2 km during sonar transmissions.

Opportunistic passive acoustic based studies have also detected behavioral responses to sonar, although definitive conclusions are harder to draw. Blue whales exposed to mid-frequency sonar in the Southern California Bight were less likely to produce low-frequency calls usually associated with feeding behavior, beginning at received levels of 110−120 dB re 1 µPa (Melcón et al., 2012); however, without visual observations it is unknown whether there was another factor that contributed to the reduction in foraging calls, such as the presence of conspecifics. In another example, Risch et al. (2012, 2014) determined that humpback whale song produced in the Stellwagen Bank National Marine Sanctuary was reduced, and since the timing was concurrent with an Ocean Acoustic Waveguide Remote Sensing experiment occurring 200 km away, they concluded that the reduced song was a result of the Ocean Acoustic Waveguide Remote Sensing. However, Gong et al. (2014) analyzed the same data set while also looking at the presence of herring in the region, and found that the singing humpbacks were actually located on nearby Georges Bank and not on Stellwagen, and that the song rate in their data did not change in response to Ocean Acoustic Waveguide Remote Sensing, but could be explained by natural causes.

Although some strong responses have been observed in mysticetes to sonar and other transducers (e.g., the single minke whale), for the most part mysticete responses appear to be fairly moderate across all received levels. While some responses such as cessation of foraging or changes in dive behavior could carry short-term impacts, in all cases behavior returned to normal after the signal stopped. Mysticete responses also seem to be highly mediated by behavioral state, with no responses occurring in some behavioral states, and contextual factors and signal characteristics having more impact than received level alone. Many of the contextual factors resulting from the behavioral response studies (e.g., close approaches by multiple vessels or tagging) would never be introduced in real Navy testing and training scenarios. While data are lacking on behavioral responses of mysticetes to continuously active sonars, these species are known to be able to habituate to novel and continuous sounds (Nowacek et al., 2004), suggesting that they are likely to have similar responses to high-duty cycle sonars. Therefore, mysticete behavioral responses to Navy sonar will likely be a result of the animal's behavioral state and prior experience rather than external variables such as ship proximity; thus, if significant behavioral responses occur, they will likely be short-term. In fact, no significant behavioral responses such as panic, stranding, or other severe reactions have been observed during monitoring of actual training exercises (Smultea et al., 2009; U.S. Department of the Navy, 2011b, 2014a; Watwood et al., 2012).

Odontocetes

Behavioral response studies have been conducted on odontocete species since 2007, with a focus on beaked whale responses to active sonar transmissions or controlled exposure playback of simulated sonar on various military ranges (Barlow et al., 2020; Claridge et al., 2009; Defence Science and Technology Laboratory, 2007; Falcone et al., 2017; Henderson et al., 2015; Henderson et al., 2016; Isojunno et al., 2020; Manzano-Roth et al., 2016; Manzano-Roth et al., 2013; McCarthy et al., 2011; Moretti et al., 2009; Southall et al., 2014; Southall et al., 2013; Southall et al., 2015; Southall et al., 2012a; Southall et al., 2011; Southall et al., 2012b; Tyack et al., 2011). Through analyses of these behavioral response studies, a preliminary overarching effect of greater sensitivity to most anthropogenic exposures was seen in beaked whales compared to the other odontocetes studied (Southall et al., 2009).

Observed reactions by Blainville's, Cuvier's, and Baird's beaked whales to mid-frequency sonar sounds have included cessation of clicking, decline in group vocal periods, termination of foraging dives, changes in direction to avoid the sound source, slower ascent rates to the surface, longer deep and shallow dive durations, and other unusual dive behavior (Boyd et al., 2008; Defence Science and Technology Laboratory, 2007; DeRuiter et al., 2013b; Miller et al., 2015; Southall et al., 2011; Stimpert et al., 2014; Tyack et al., 2011). Similar responses have been observed in northern bottlenose whales, one of which conducted the longest and deepest dive on record for that species after the sonar exposure and continued swimming away from the source for over seven hours (Miller et al., 2015; Wensveen et al., 2019). Responses have occurred at received levels between 95 and 150 dB re 1 μPa. Many of these exposures occurred within 1–8 km of the focal animal, within a few hours of tagging the animal, and with one or more boats within a few kilometers to observe responses and record acoustic data. One Cuvier's beaked whale was also incidentally exposed to real Navy sonar located over 100 km away, and the authors did not detect similar responses at comparable received levels. Received levels from the mid-frequency active sonar signals from the controlled and incidental exposures were calculated as 84–144 and 78–106 dB re 1 μPa, respectively, indicating that context of the exposures (e.g., source proximity, controlled source ramp-up) may have been a significant factor in the responses to the simulated sonars (DeRuiter et al., 2013b). However, in a remote environment where sonar exposure is rare, similar responses in northern bottlenose whales were detected in whales up to 28 km away from the source at modeled received levels estimated at 117–126 dB re 1 μPa with no vessel nearby (von Benda-Beckmann et al., 2019; Wensveen et al., 2019). One northern bottlenose whale did approach the ship and circle the source, then resumed foraging after the exposure, but the source level was only 122 dB re 1 µPa.

Falcone et al. (2017) modeled deep and shallow dive durations, surface interval durations, and inter-deep dive intervals of Cuvier's beaked whales against predictor values that included helicopter dipping, mid-power mid-frequency active sonar and hull-mounted, high-power mid-frequency active sonar along with other, non-mid-frequency active sonar predictors. They found both shallow and deep dive durations to increase as the proximity to both mid- and high-powered sources decreased, and found surface intervals and inter-deep dive intervals to also increase in the presence of both types of sonars, although surface intervals shortened during periods of no mid-frequency active sonar. The responses to the mid-power mid-frequency active sonar at closer ranges were comparable to the responses to the higher SL ship sonar, again highlighting the importance of proximity. This study also supports context as a response factor, as helicopter dipping sonars are shorter duration and randomly located, so more difficult for beaked whales to predict or track and therefore potentially more likely to cause a response, especially when they occur at closer distances (6–25 km in this study). Sea floor depths and quantity of light are also important variables to consider in Cuvier beaked whale behavioral response studies, as their foraging dive depth increased with sea floor depth, foraging was more common at night, and deep dives were more common during the day (and when there was strong lunar illumination), likely to avoid predation (Barlow et al., 2020). Watwood et al. (2017) found that helicopter dipping events occurred more frequently but with shorter durations than periods of hull-mounted sonar, and also found that the longer the duration of a sonar event, the greater reduction in detected Cuvier's beaked whale group dives. Therefore, when looking at the number of detected group dives there was a greater reduction during periods of hull-mounted sonar than during helicopter dipping sonar. Similar results were found by DiMarzio et al. (2019).

Long-term tagging work has demonstrated that the longer duration dives considered a behavioral response by DeRuiter et al. (2013b) fell within the normal range of dive durations found for eight tagged Cuvier's beaked whales on the Southern California Offshore Range (Schorr et al., 2014). However, the longer inter-deep dive intervals found by DeRuiter et al. (2013b), which were among the longest found by Schorr et al. (2014) and Falcone et al. (2017) could indicate a response to sonar. In addition, Williams et al. (2017) note that in normal deep dives or during fast swim speeds, beaked whales and other marine mammals use strategies to reduce their stroke rates, including leaping or wave surfing when swimming, and interspersing glides between bouts of stroking when diving. They determined that in the post-exposure dives by the tagged Cuvier's beaked whales described in DeRuiter et al. (2013b), the whales ceased gliding and swam with almost continuous strokes. This change in swim behavior was calculated to increase metabolic costs about 30.5 percent and increase the amount of energy expending on fast swim speeds from 27 to 59 percent of their overall energy budget. This repartitioning of energy was detected in the model up to 1.7 hours after the single sonar exposure. Therefore, while the overall post-exposure dive durations were similar, the metabolic energy calculated by Williams et al. (2017) was higher. However, Southall et al. (2019a) found that prey availability was higher in the western area of the Southern California Offshore Range where Cuvier's beaked whales preferentially occurred, while prey resources were lower in the eastern area and moderate in the area just north of the Range. This high prey availability may indicate that fewer foraging dives are needed to meet metabolic energy requirements than would be needed in another area with fewer resources.

Wensveen et al. (2019) examined the roles of sound source distance and received level in northern bottlenose whales in an environment without frequent sonar activity using controlled exposure experiments. They observed behavioral avoidance of the sound source over a wide range of distances (0.8–28 km) and estimated avoidance thresholds ranging from received SPLs of 117–126 dB re 1 µPa. The behavioral response characteristics and avoidance thresholds were comparable to those previously observed in beaked whale studies; however, they did not observe an effect of distance on behavioral response and found that onset and intensity of behavioral response were better predicted by received SPL. Joyce et al. (2019) examined modeled received sound levels, dive data, and horizontal movement of seven satellite-tagged Blainville's beaked whales before, during, and after mid-frequency active sonar training at the Atlantic Undersea Test and Evaluation Center instrumented range. They found a decline in deep dives at the onset of the training and an increase in time spent on foraging dives as individuals moved away from the range. Predicted received levels at which presumed responses were observed were comparable to those previously observed in beaked whale studies. Acoustic data indicated that vocal periods were detected on the range within 72 hours after training ended.

On Navy ranges, Blainville's beaked whales located on the range appear to move off-range during sonar use and return only after the sonar transmissions have stopped, sometimes taking several days to do so (Claridge et al., 2009; Henderson et al., 2015; Manzano-Roth et al., 2016; McCarthy et al., 2011; Moretti et al., 2009; Tyack et al., 2011). For example, five Blainville's beaked whales that were estimated to be within 2–29 km of the Atlantic Undersea Test and Evaluation Center range at the onset of sonar were displaced a maximum of 28–68 km from the range after moving away from the range, although one whale approached the range during the period of active sonar (Joyce et al., 2019). However, Blainville's beaked whales remain on the range to forage throughout the rest of the year (Henderson et al., 2016), possibly indicating that this a preferred foraging habitat regardless of the effects of the noise, or it could be that there are no long-term consequences of the sonar activity. Similarly, photo-identification studies in the Southern California Range Complex have identified approximately 100 individual Cuvier's beaked whale individuals, with 40 percent having been seen in one or more prior years, with re-sightings up to seven years apart, indicating a possibly resident population on the range (Falcone & Schorr, 2014; Falcone et al., 2009).

Beaked whales may respond similarly to shipboard echosounders, commonly used for navigation, fisheries, and scientific purposes, with frequencies ranging from 12 to 400 kHz and source levels up to 230 dB re 1 µPa but typically a very narrow beam (Cholewiak et al., 2017). During a scientific cetacean survey, an array of echosounders was used in a one-day-on, one-day-off paradigm. Beaked whale acoustic detections occurred predominantly (96 percent) when the echosounder was off, with only four detections occurring when it was on. Beaked whales were sighted fairly equally when the echosounder was on or off, but sightings were further from the ship when the echosounder was on (Cholewiak et al., 2017). These findings indicate that the beaked whales may be avoiding the area and may cease foraging near the echosounder. On the other hand, Varghese et al. (2020) analyzed group vocal periods from Cuvier's beaked whales during multibeam echosounder activity recorded in the Southern California Antisubmarine Warfare Range and failed to find any clear evidence of behavioral response due to the echosounder survey. The whales did not leave the range or cease foraging.

Tyack et al. (2011) hypothesized that beaked whale responses to sonar may represent an anti-predator response. To test this idea, vocalizations of a potential predator—a killer whale—were also played back to a Blainville's beaked whale. This exposure resulted in a similar but more pronounced reaction than that elicited by sonar playback, which included longer inter-dive intervals and a sustained straight-line departure of more than 20 km from the area (Allen et al., 2014; Tyack et al., 2011). De Soto et al. (2020) hypothesized that the high degree of vocal synchrony in beaked whales during their deep foraging dives, coupled with their silent, low-angled ascents, have evolved as an anti-predator response to killer whales. Since killer whales do not dive deep when foraging and so may be waiting at the surface for animals to finish a dive, these authors speculated that by diving in spatial and vocal cohesion with all members of their group, and by surfacing silently and up to a kilometer away from where they were vocally active during the dive, they minimize the ability of killer whales to locate them when at the surface. This may lead to a trade-off for the larger, more fit animals that could conduct longer foraging dives, such that all members of the group remain together and are better protected by this behavior. The authors further speculate that this may explain the long, slow, silent, and shallow ascents that beaked whales make when sonar occurs during a deep foraging dive. However, these hypotheses are based only on the dive behavior of tagged beaked whales, with no observations of predation attempts by killer whales, and need to be tested further to be validated. This anti-predator hypothesis was also tested by playing back killer whale vocalizations to pilot whales, sperm whales, and even other killer whales, to determine responses by both potential prey and conspecifics (Miller, 2012; Miller et al., 2011). Results varied, from no response by killer whales to an increase in group size and attraction to the source in pilot whales (Curé et al., 2012). Gotz et al. (2020) tested startle responses in bottlenose dolphins and found that these responses can occur at moderate received levels and mid-frequencies, and that the relationship between rise time and startle response was more gradual than expected in an odontocete. They therefore hypothesize that the extreme responses of beaked whales to sonar could be a form of startle response, rather than an anti-predator response.

While there has been a focus on beaked whale responses to sonar, other species have been studied during behavioral response studies as well, including pilot whales, killer whales, and sperm whales. Responses by these species have also included horizontal avoidance, reduced breathing rates, changes in behavioral state, and changes in dive behavior (Antunes et al., 2014; Isojunno et al., 2018; Isojunno et al., 2017; Isojunno et al., 2020; Miller, 2012; Miller et al., 2011; Miller et al., 2014). Additionally, separation of a killer whale calf from its group during exposure to mid-frequency sonar playback was observed (Miller et al., 2011). Received level thresholds at the onset of avoidance behavior were generally higher for pilot whales (mean 150 dB re 1 µPa) and sperm whales (mean 140 dB re 1 µPa) than killer whales (mean 129 dB re 1 µPa) (Antunes et al., 2014; Miller, 2012; Miller et al., 2014). A close examination of the tag data from the Norwegian killer whales indicated that responses were mediated by behavior, signal frequency, or received sound energy. For example, killer whales only changed their dive behavior when doing deep dives at the onset of 1−2 kHz sonar (sweeping across frequencies), but did not change their dive behavior if they were deep-diving during 6−7 kHz sonar (sweeping across frequencies). Nor did they change their dive behavior if they were conducting shallow dives at the onset of either type of sonar. Similarly, pilot whales and sperm whales performed normal deep dives during 6−7 kHz sonar (and more deep foraging dives than during baseline for the pilot whales), while during 1−2 kHz sonar the pilot whales conducted fewer deep dives and the sperm whales performed shorter and shallower dives (Sivle et al., 2012). In addition, pilot whales were also more likely to respond to lower received levels when non-feeding than feeding during 6−7 kHz sonar exposures, but were more likely to respond at higher received levels when non-feeding during 1−2 kHz sonar exposures. Foraging time in pilot whales was reduced during the initial sonar exposure (both MFAS and LFAS), with a concurrent increase in travel behavior; however, foraging increased again during subsequent exposures, potentially indicating some habituation (Isojunno et al., 2017). No reduction in foraging was observed during killer whale playbacks. Cessation of foraging appeared to occur at a lower received level of 145–150 dB re 1 µPa than had been observed previously for avoidance behavior (around 170 dB re 1 µPa; Antunes et al., 2014). Pilot whales also exhibited reduced breathing rates relative to their diving behavior when the LFAS levels were high (reaching 180 dB re 1 µPa), but only on the first sonar exposure; on subsequent exposures their breathing rates increased (Isojunno et al., 2018) indicating a change in response tactic with additional exposures. Furthermore, pilot whales exposed to a 38 kHz downward-facing echosounder did not change their dive and foraging behavior during exposure periods, although the animals' heading variance increased and fewer deep dives were conducted (Quick et al., 2017). In contrast, killer whales were more likely to respond to either sonar type when non-feeding than when feeding (Harris et al., 2015). Sperm whales were exposed to pulsed active sonar (1-2 kHz) at moderate source levels and high source levels, as well as continuously active sonar at moderate levels for which the summed energy (SEL) equaled the summed energy of the high source level pulsed sonar (Isojunno et al., 2020). Foraging behavior did not change during exposures to moderate source level sonar, but non-foraging behavior increased during exposures to high source level sonar and to the continuous sonar, indicating that the energy of the sound (the sound exposure level) was a better predictor of response than SPL. However, the time of day of the exposure was also an important covariate in determining the amount of non-foraging behavior, as were order effects (e.g., the SEL of the previous exposure). These results again demonstrate that the behavioral state and environment of the animal mediates the likelihood of a behavioral response, as do the characteristics (e.g., frequency, energy level) of the sound source itself. Further, the highly flexible activity time budgets observed for pilot whales, with a large amount of time spent resting at the surface, may indicate context-dependency on some behaviors, such as the presence of prey driving periods of foraging. Therefore, that time may be more easily re-allocated to missed foraging opportunities, leading to less severe population consequences of periods of reduced foraging (Isojunno et al., 2017).

Other responses during behavioral response studies included the synchronization of pilot whale surfacings with sonar pulses during one exposure, possibly as a means of mitigating the sound (Wensveen et al., 2015), and mimicry of the sonar with whistles by pilot whales (Alves et al., 2014), false killer whales (DeRuiter et al., 2013a) and Risso's dolphins (Smultea et al., 2012). In contrast, in another study melon-headed whales had "minor transient silencing" (a brief, non-lasting period of silence) after each 6–7 kHz signal, and (in a different oceanographic region) pilot whales had no apparent response (DeRuiter et al., 2013a). The probability of detecting delphinid vocalizations (whistles, clicks, and buzzes) increased during periods of sonar relative to the period prior to sonar in a passive acoustic study using Marine Autonomous Recording Units in the Jacksonville Range Complex, while there was no impact of sonar to the probability of detecting sperm whale clicks (Charif et al., 2015; U.S. Department of the Navy, 2013a).

In addition, killer whale sighting data from the same region in Norway as the behavioral response study was used to compare the presence or absence of whales from other years against the period with sonar. The authors found a strong relationship between the presence of whales and the abundance of herring, and only a weak relationship between the whales and sonar activity (Kuningas et al., 2013). Baird et al. (2014; 2017; 2013) also tagged four shallow-diving odontocete species (rough-toothed dolphins, pilot whales, bottlenose dolphins, and false killer whales) in Hawaii off the Pacific Missile Range Facility before Navy training events. None of the tagged animals demonstrated a large-scale avoidance response to the sonar as they moved on or near the range, in some cases even traveling towards areas of higher noise levels, while estimated received SPLs varied from 130 to 168 dB re 1 µPa and distances from sonar sources ranged between 3.2 and 94.4 km. However, one pilot whale did have reduced dive rates (from 2.6 dives per hour before to 1.6 dives per hour during) and deeper dives (from a mean of 124 m to 268 m) during a period of sonar exposure. Baird et al. (2016) also tagged four short-finned pilot whales from both the resident island-associated population and from the pelagic population. The core range for the pelagic population was over 20 times larger than for the pelagic population, leading Baird et al. (2016) to hypothesize that that likelihood of exposure to mid-frequency active sonar, and therefore the potential for response, would be very different between the two populations. These diverse examples demonstrate that responses can be varied, are often context- and behavior-driven, and can be species and even exposure specific.

Other opportunistic observations of behavioral responses to sonar have occurred as well, although in those cases it is difficult to attribute observed responses directly to the sonar exposure, or to know exactly what form the response took. For example, both sperm and pilot whales potentially ceased sound production during the Heard Island feasibility test, with transmissions centered at 57 Hz and up to 220 dB re 1 µPa (Bowles et al., 1994), although it could not be determined whether the animals ceased sound production or left the area. In May 2003, killer whales in Haro Strait, Washington, exhibited what were believed by some observers to be aberrant behaviors, during which time the USS Shoup was in the vicinity and engaged in mid-frequency active sonar operations. Sound fields modeled for the USS Shoup transmissions (Fromm, 2009; National Marine Fisheries Service, 2005; U.S. Department of the Navy, 2004) estimated a mean received SPL of approximately 169 dB re 1 µPa at the location of the killer whales at the closest point of approach between the animals and the vessel (estimated SPLs ranged from 150 to 180 dB re 1 µPa). However, attributing the observed behaviors to any one cause is problematic given there were six nearby whale watch vessels surrounding the pod, and subsequent research has demonstrated that "Southern Residents modify their behavior by increasing surface activity (breaches, tail slaps, and pectoral fin slaps) and swimming in more erratic paths when vessels are close" (National Oceanic and Atmospheric Administration, 2014b). Several odontocete species, including bottlenose dolphins, Risso's dolphins, Pacific white-sided dolphins, and common dolphins have been observed near the Southern California Offshore Range during periods of mid-frequency active sonar; responses included changes in or cessation of vocalizations, changes in behavior, and leaving the area, and at the highest received levels animals were not present in the area at all (Henderson et al., 2014b). However, these observations were conducted from a vessel off-range, and so any observed responses could not be attributed to the sonar with any certainty. Research on sperm whales in the Caribbean in 1983 coincided with the U.S. intervention in Grenada, where animals were observed scattering and leaving the area in the presence of military sonar, presumably from nearby submarines (Watkins et al., 1985; Watkins & Schevill, 1975). The authors did not report received levels from these exposures and reported similar reactions from noise generated by banging on their boat hull; therefore, it was unclear if the sperm whales were reacting to the sonar signal itself or to a potentially new unknown sound in general.

During aerial and visual monitoring of Navy training events involving sonar, rough-toothed dolphins and unidentified dolphins were observed approaching the vessel with active sonar as if to bow ride, while spotted dolphins were observed nearby but did not avoid or approach the vessel (Mobley, 2011; U.S. Department of the Navy, 2011a; Watwood et al., 2012). During small boat surveys near the Southern California Offshore Range in southern California, more dolphins were encountered in June compared to a similar survey conducted the previous November after 7 days of mid-frequency sonar activity; it was not investigated if this change was due to the sonar activity or was due to the poor weather conditions in November that may have prevented animals from being seen (Campbell et al., 2010). There were also fewer passive acoustic dolphin detections during and after longer sonar activities in the Mariana Islands Range Complex, with the post-activity absence lasting longer than the mean dolphin absence of two days when sonar was not present (Munger et al., 2014; Munger et al., 2015).

Acoustic harassment devices and acoustic deterrent devices, which transmit sound into the acoustic environment similar to Navy sources, have been used to deter marine mammals from fishing gear both to prevent entanglement and to reduce depredation (taking fish). These devices have been used successfully to deter harbor porpoises and beaked whales from getting entangled in fishing nets. For example, Kyhn et al. (2015) tested two types of pingers, one with a 10 kHz tone and one with a broadband 30−160 kHz sweep. Porpoise detection rates were reduced by 65 percent for the sweep and 40 percent for the tone, and while there was some gradual habituation after the first two to four exposures, longer term exposures (over 28 days) showed no evidence of additional habituation. Omeyer et al. (2020) also tested a 50–120 kHz pinger near harbor porpoise and found a 37 percent reduction in detections at the recorder near the pinger, but only a 9 percent reduction at a recorder 100 m away, indicating a response only occurred in relatively close proximity to the pinger. While clicking returned to normal levels as soon as the pinger was shut off (implying no long-term displacement), the response to the active pinger remained consistent over the nine-month study period, indicating no habituation occurred and the pingers remained an effective deterrent. Similarly, Kindt-Larsen et al. (2019) tested two pinger types in four configurations, and found that while both pingers effectively deterred harbor porpoises, their effect decreased with increasing distance (although their effective distance was limited to a few hundred m). In addition, a species' habituation to a pinger may occur with single tones, but it is less likely with a mixture of signals. Additionally, sperm whales in the Caribbean stopped vocalizing when presented with sounds from nearby acoustic pingers (Watkins & Schevill, 1975). However, acoustic harassment devices used to deter marine mammals from depredating long lines or aquaculture enclosures have proven less successful. For example, Tixier et al. (2014) used a 6.5 kHz pinger with a source level of 195 dB re 1 μPa on a longline to prevent depredation by killer whales, and although two groups of killer whales fled over 700 m away during the first exposure, they began depredating again after the 3rd and 7th exposures, indicating rapid habituation. In a review of marine mammal deterrents, Schakner & Blumstein (2013) point out that both the characteristics of deterrents and the motivation of the animal play a role in the effectiveness of acoustic harassment devices. Deterrents that are strongly aversive or simulate a predator or are otherwise predictive of a threat are more likely to be effective, unless the animal habituates to the signal or learns that there is no true threat associated with the signal. In some cases net pingers may create a "dinner bell effect," where marine mammals have learned to associate the signal with the availability of prey (Jefferson & Curry, 1996; Schakner & Blumstein, 2013). This may be why net pingers have been more successful at reducing entanglements for harbor porpoise and beaked whales since these species are not depredating from the nets but are getting entangled when foraging in the area and are unable to detect the net (Carretta et al., 2008; Schakner & Blumstein, 2013). Niu et al. (2012) and Niu et al. (2020) exposed captive dolphins to pulsed and continuous tonal signals to investigate acoustic deterrence. For all test frequencies, the dolphins increased surfacing distance relative to transducer, surfaced more often, and reduced clicks compared to baseline. Although some acclimatization was observed during daily tests, no habituation was observed over the full duration of the studies. Bowles and Anderson (2012) exposed a variety of species in captivity to novel objects, including a fishing net and anchor with line, both with and without a gillnet pinger. Responses varied broadly by species, with three species of pinniped showing mild avoidance of the net with the pinger. In contrast, the Pacific white-sided dolphin approached the gillnet without a pinger but avoided it completely when the pinger was added, and Commerson's dolphins demonstrated strong behavioral responses to the pinger including high speed swimming and other high energy behavior, increased use of a refuge pool, and increased rates of vocalizations. In further trials meant to test habituation, the Commerson's dolphins appeared to sensitize to the pinger instead, with even stronger aversive behavior.

Similarly, a 12 kHz acoustic harassment device intended to scare seals was ineffective at deterring seals but effectively caused avoidance in harbor porpoises out to over 500 m from the source, highlighting different species- and device-specific responses (Mikkelsen et al., 2017). Likewise, in a long-term study of killer whale occurrence in inland waters off British Columbia, a region that had been used regularly from 1985 to 1993, showed a significant decrease in killer whale occurrence from 1993 to 1999 when four acoustic deterrent devices were deployed on seal farms; during the same time frame there was no evidence in a reduction in seals in the same area, although they were the intended targets of the devices (Morton & Symonds, 2002). During the same time period, no reduction in killer whale occurrence was detected at an adjacent location, leading to the conclusion that the killer whales were avoiding the area ensonified by the deterrent devices. Once the devices were removed, the killer whales returned to the affected area in similar numbers as had previously occurred. Additional behavioral studies have been conducted with captive harbor porpoises using acoustic alarms, such as those used on fishing nets to help deter marine mammals from becoming caught or entangled (Kastelein et al., 2006; Kastelein et al., 2001). These studies have found that high-frequency sources with varied duration, interval, and sweep characteristics can prove to be effective deterrents for harbor porpoises (Kastelein et al., 2017d). Van Beest et al. (2017) modeled the long-term, population-level impacts of fisheries bycatch, pinger deterrents, and time-area closures on a population of harbor porpoises. They found that when pingers were used alone (in the absence of gillnets or time-area closures), the animals were deterred from the area often enough to cause a population-level reduction of 21 percent, greater even than the modeled level of current bycatch impacts. However, when the pingers were coupled with gillnets in the model, and time-area closures were also used (allowing a net- and pinger-free area for the porpoises to move into while foraging), the population only experienced a 0.8 percent decline even with current gillnet use levels. This demonstrates that, when used correctly, pingers can successfully deter porpoises from gillnets without leading to any negative impacts.

Controlled experiments have also been conducted on captive animals to estimate received levels at which behavioral responses occur. In one study, bottlenose dolphin behavioral responses were recorded when exposed to 3 kHz sonar-like tones between 115 and 185 dB re 1 μPa (Houser et al., 2013a), and in another study bottlenose dolphins and beluga whales were presented with one-second tones up to 203 dB re 1 μPa to measure TTS (Finneran et al., 2003a; Finneran et al., 2001; Finneran et al., 2005b; Finneran & Schlundt, 2004; Schlundt et al., 2000). During these studies, responses included changes in respiration rate, fluke slaps, and a refusal to participate or return to the location of the sound stimulus. This refusal included what appeared to be deliberate attempts to avoid a sound exposure or to avoid the location of the exposure site during subsequent tests (Finneran et al., 2002; Schlundt et al., 2000). In the behavioral response study, bottlenose dolphins demonstrated a 50 percent probability of response at 172 dB re 1 μPa over 10 trials. In the TTS experiment, bottlenose dolphins exposed to one-second intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1 μPa; beluga whales did so at received levels of 180 to 196 dB re 1 μPa and above. In some instances, animals exhibited aggressive behavior toward the test apparatus (Ridgway et al., 1997; Schlundt et al., 2000). While animals were commonly reinforced with food during these studies, the controlled environment and ability to measure received levels provide insight on received levels at which animals will behaviorally responds to noise sources.

Behavioral responses to a variety of sound sources have been studied in captive harbor porpoises, including acoustic alarms (Kastelein et al., 2006; Kastelein et al., 2001), emissions for underwater data transmission (Kastelein et al., 2005b), and tones, including 1–2 kHz and 6–7 kHz sweeps with and without harmonics (Kastelein et al., 2014c), 25 kHz with and without sidebands (Kastelein et al., 2015f; Kastelein et al., 2015g), and mid-frequency sonar tones at 3.5–4.1 kHz at 2.7 percent and 96 percent duty cycles (e.g., one tone per minute versus a continuous tone for almost a minute) (Kastelein et al., 2018b). Responses include increased respiration rates, more jumping, or swimming further from the source, but responses were different depending on the source. For example, harbor porpoises responded to the 1−2 kHz upsweep at 123 dB re 1 μPa, but not to the downsweep or the 6−7 kHz tonal at the same level (Kastelein et al., 2014c). When measuring the same sweeps for a startle response, the 50 percent response threshold was 133 and 101 dB re 1 μPa for 1−2 kHz and 6−7 kHz sweeps, respectively, when no harmonics were present, and decreased to 90 dB re 1 μPa for 1−2 kHz sweeps with harmonics present (Kastelein et al., 2014c). Harbor porpoises did not respond to the low-duty cycle mid-frequency tones at any received level, but one did respond to the high-duty cycle signal with more jumping and increased respiration rates (Kastelein et al., 2018b). Harbor porpoises responded to seal scarers with broadband signals up to 44 kHz with a slight respiration response at 117 dB re 1 μPa and an avoidance response at 139 dB re 1 μPa, but another scarer with a fundamental (strongest) frequency of 18 kHz did not have an avoidance response until 151 dB re 1 μPa (Kastelein et al., 2015e). Exposure of the same acoustic pinger to a striped dolphin under the same conditions did not elicit a response (Kastelein et al., 2006), again highlighting the importance in understanding species differences in the tolerance of underwater noise, although sample sizes in these studies was small so these could reflect individual differences as well. Lastly, Kastelein et al. (2019a) examined the potential masking effect of high sea state ambient noise on captive harbor porpoise perception of and response to high duty cycle playbacks of AN/SQS-53C sonar signals by observing their respiration rates. Results indicated that sonar signals were not masked by the high sea state noise, and received levels at which responses were observed were similar to those observed in prior studies of harbor porpoise behavior.

Behavioral responses by odontocetes to sonar and other transducers appear to range from no response at all to responses that could potentially lead to long-term consequences for individual animals (e.g., mother-calf separation). This is likely in part due to the fact that this taxonomic group is so broad and includes some of the most sensitive species (e.g., beaked whales and harbor porpoise) as well as some of the least sensitive species (e.g., bottlenose dolphins). This is also the only group for which both field behavioral response studies and captive controlled exposure experiments have been conducted, leading to the assessment of both contextually driven responses as well as dose-based responses. This wide range in both exposure situations and individual- and species-sensitivities makes reaching general conclusions difficult. However, it does appear as though exposures in close proximity, with multiple vessels that approach the animal lead to higher-level responses in most odontocete species regardless of received level or behavioral state. In contrast, in more “real-world” exposure situations, with distant sources moving in variable directions, behavioral responses appear to be driven by behavioral state, individual experience or species-level sensitivities. These responses may also occur more in-line with received level such that the likelihood of a response would increase with increased received levels. However, these “real-world” responses are more likely to be short-term, lasting the duration of the exposure or even shorter as the animal assesses the sound and (based on prior experience or contextual cues) determines a threat is unlikely. Therefore, while odontocete behavioral responses to Navy sonar will vary across species, populations, and individuals, they are not likely to lead to long-term consequences or population-level effects.

Pinnipeds

Different responses displayed by captive and wild phocid seals to sound judged to be "unpleasant" or threatening have been reported, including habituation by captive seals (they did not avoid the sound), and avoidance behavior by wild seals (Götz & Janik, 2010). Captive seals received food (reinforcement) during sound playback, while wild seals were exposed opportunistically. These results indicate that motivational state (e.g., reinforcement via food acquisition) can be a factor in whether or not an animal tolerates or habituates to novel or unpleasant sounds. Another study found that captive hooded seals reacted to 1–7 kHz sonar signals, in part with displacement (i.e., avoidance) to the areas of least SPL, at levels between 160 and 170 dB re 1 µPa (Kvadsheim et al., 2010b); however, the animals adapted to the sound and did not show the same avoidance behavior upon subsequent exposures. Captive harbor seals responded differently to three signals at 25 kHz with different waveform characteristics and duty cycles. The seals responded to the frequency modulated signal at received levels over 137 dB re 1 µPa by hauling out more, swimming faster, and raising their heads or jumping out of the water, but did not respond to the continuous wave or combination signals at any received level (up to 156 dB re 1 µPa) (Kastelein et al., 2015d). Captive California sea lions were exposed to mid-frequency sonar at various received levels (125–185 dB re 1 µPa) during a repetitive task (Houser et al., 2013a). Behavioral responses included a refusal to participate, hauling out, an increase in respiration rate, and an increase in the time spent submerged. Young animals (less than two years old) were more likely to respond than older animals. Dose-response curves were developed both including and excluding those young animals. The majority of responses below 155 dB re 1 µPa were changes in respiration, whereas over 170 dB re 1 µPa more severe responses began to occur (such as hauling out or refusing to participate); many of the most severe responses came from the younger animals.

Low-frequency signals of the Acoustic Thermometry of Ocean Climate sound source centered at 75 Hz, with received levels between 118 and 137 dB re 1 µPa, were not found to overtly affect elephant seal dives (Costa et al., 2003). However, they did produce subtle effects that varied in direction and degree among the individual seals, again illustrating the equivocal nature of behavioral effects and consequent difficulty in defining and predicting them.

Harbor seals exposed to seal scarers (i.e., acoustic harassment devices) used to deter seals from fishing nets did not respond at levels of 109–134 dB re 1 µPa and demonstrated minor responses by occasionally hauling out at 128–138 dB re 1 µPa (Kastelein et al., 2015c). Pingers have also been used to deter marine mammals from fishing nets; in some cases, this has led to the "dinner bell effect," where the pinger becomes an attractant rather than a deterrent (Carretta & Barlow, 2011). Steller sea lions were exposed to a variety of tonal, sweep, impulse and broadband sounds. The broadband sounds did not cause a response, nor did the tones at levels below 165 dB re 1 µPa at 1 m, but the 8 kHz tone and 1–4 kHz sweep at source levels of 165 dB re 1 µPa caused the sea lions to haul out (Akamatsu et al., 1996).

Similar to the other taxonomic groups assessed, pinniped behavioral responses to sonar and other transducers seem to be mediated by the contextual factors of the exposure, including the proximity of the source, the characteristics of the signal, and the behavioral state of the animal. However, all pinniped behavioral response studies have been conducted in captivity, so while these results may be broadly applied to real-world exposure situations, it must be done with caution. Based on exposures to other sound sources in the wild (e.g., impulsive sounds and vessels), pinnipeds are not likely to respond strongly to Navy sonar that is not in close proximity to the animal or approaching the animal.

Sea Otters

There is no research on the effects of sonar on sea otters. Sea otters spend approximately 80 percent of their time on the surface of the water (Curland, 1997) with their heads above the surface, which reduces their exposure to underwater sounds. They may show similar reactions to those of pinnipeds which are also amphibious hearers. However, underwater hearing sensitivities are significantly reduced in sea otters when compared to pinnipeds (Ghoul & Reichmuth, 2014a, 2014b), so any reactions may have lower overall severity. Pinnipeds may haul out, swim faster, or increase their respiration rate in response to sonar (Houser et al., 2013a; Kastelein et al., 2015d). Pinnipeds also showed that they may avoid an area temporarily, but may habituate to sounds quickly (Kvadsheim et al., 2010a; Kvadsheim et al., 2010b). Deviations from pinniped behavior could be a result of sea otter dives being energetically costly (i.e., requiring twice the metabolic energy that phocid seals need to dive). Therefore, sea otters may not dive or travel far in response to disturbance, as they already require long periods of rest at the surface to counterbalance the high metabolic cost of foraging at sea (Yeates et al., 2007). Sea otters may also habituate to sonar signals. However, sea otters live too far inshore to likely be exposed to or impacted by Navy sonar or other transducers, and live out of the area of pierside activity.

Behavioral Reactions to Vessel Noise

Sound emitted from large vessels, such as cargo ships, is the principal source of low-frequency noise in the ocean today, and marine mammals are known to react to or be affected by that noise (Hatch & Wright, 2007; Hildebrand, 2005; Richardson et al., 1995b). For example, Erbe et al. (2012) estimated the maximum annual underwater SEL from vessel traffic near Seattle was 215 dB re 1 μPa^2-s, and Bassett et al. (2010) measured mean SPLs at Admiralty Inlet from commercial shipping at 117 dB re 1 µPa with a maximum exceeding 135 dB re 1 µPa on some occasions. Similarly, Veirs et al. (2015) found average broadband noise levels in Haro Strait to be 110 dB re 1 µPa that extended up to 40 kHz, well into the hearing range of odontocetes.

Many studies of behavioral responses by marine mammals to vessels have been focused on the short-and long-term impacts of whale watching vessels. In short-term studies, researchers noted changes in resting and surface behavior states of cetaceans to whale watching vessels (Acevedo, 1991; Aguilar de Soto et al., 2006; Arcangeli & Crosti, 2009; Au & Green, 2000; Christiansen et al., 2010; Erbe, 2002; Noren et al., 2009; Stockin et al., 2008; Williams et al., 2009). Received levels were often not reported so it is difficult to distinguish responses to the presence of the vessel from responses to the vessel noise. Most studies examined the short-term response to vessel sound and vessel traffic (Magalhães et al., 2002; Richardson et al., 1995b; Watkins, 1981), with behavioral and vocal responses occurring when received levels were over 20 dB greater than ambient noise levels. Other research has attempted to quantify the effects of whale watching using focused experiments (Meissner et al., 2015; Pirotta et al., 2015b).

The impact of vessel noise has received increased consideration, particularly as whale watching and shipping traffic has risen (McKenna et al., 2012; Pirotta et al., 2015b; Veirs et al., 2015). Odontocetes and mysticetes in particular have received increased attention relative to vessel noise and vessel traffic, with pinnipeds and sea otters less so. The impacts of ship noise on marine mammals also appear to be largely context- and species-dependent (Erbe et al., 2019). Still, not all species in all taxonomic groups have been studied, and so results do have to be extrapolated across these broad categories in order to assess potential impacts.

Mysticetes

Baleen whales demonstrate a variety of responses to vessel traffic and noise, from not responding at all to both horizontal (swimming away) and vertical (increased diving) avoidance (Baker et al., 1983; Fiori et al., 2019; Gende et al., 2011; Watkins, 1981). Other common responses include changes in vocalizations, call rate, surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions (Au & Green, 2000; Dunlop, 2019; Fournet et al., 2018; Machernis et al., 2018; Richter et al., 2003; Williams et al., 2002a).

The likelihood of response may be driven by the distance, speed, approach, or noise level of the vessel, the animal's behavioral state, or by the prior experience of the individual or population. For example, in one study fin and humpback whales largely ignored vessels that remained 100 m or more away (Watkins, 1981). In another study, minke whales in the Antarctic did not show any apparent response to a survey vessel moving at normal cruising speeds (about 12 knots) at a distance of 5.5 NM. However, when the vessel drifted or moved at very slow speeds (about 1 knot), many whales approached it (Leatherwood et al., 1982). Similarly, Bernasconi et al. (2012) observed the reactions of six individual baleen whales of unknown species at distances of 50–400 m from a fishing vessel conducting an acoustic survey of pelagic fisheries, with only a slight change in swim direction when the vessel began moving around the whales. Gray whales were likely to continue feeding when approached by a vessel in areas with high motorized vessel traffic, but in areas with less motorized vessel traffic they were more likely to change behaviors, either indicating habituation to vessels in high traffic area, or indicating possible startle reactions to close-approaching non-motorized vessels (e.g., kayaks) in quieter areas (Sullivan & Torres, 2018). Changes in behavior of humpback whales when vessels came within 500 m were also dependent on behavioral state such that they would keep feeding but were more likely to start traveling if they were surface active when approached (Di Clemente et al., 2018). Changes in humpback whale behavior were also affected by time of day, season, or the type of vessel approach(Di Clemente et al., 2018; Fiori et al., 2019). Avoidance responses occurred most often after "J" type vessel approaches (i.e., traveling parallel to the whales' direction of travel, then overtaking the whales by turning in front of the group) compared to parallel or direct approaches; mother humpbacks were particularly sensitive to direct and J type approaches and spent significantly more time diving in response (Fiori et al., 2019). Humpback whales changed their acoustic and social behavior when vessels were present; their communication area was reduced by half in average vessel-dominated noise (105 dB re 1 µPa), but the physical presence of vessels was the major contributing factor to decreased social interactions (Dunlop, 2019). In contrast, for resting humpback whale mother-calf pairs, the presence of a passing vessel did not change their behavior, but fast vessels with louder low-frequency weighted source levels of 173 dB re 1 µPa, equating to weighted received levels of 133 dB re 1 µPa at an average distance of 100 m, led to a decrease in resting behavior and increase in dives, swim speeds, and respiration rates (Sprogis et al., 2020). Migrating humpback whales reacted similarly to vessels towing seismic air gun arrays, regardless of whether the air guns were active or not; this indicates that it was the presence of ships (rather than the active air guns) that reduced social interactions between males and mother-calf pairs (Dunlop et al., 2020).

In response to an approaching large commercial vessel in an area of high ambient noise levels (125-130 dB re 1 uPa), a tagged female blue whale turned around mid-ascent, and decended perpendicular to the ship's path (Szesciorka et al., 2019). The whale did not respond until the ship's closest point of approach (100 m distance, 135 dB re 1 uPa),which was only 10 dB above the ambient noise levels. After the ship passed, the whale ascended to the surface again with a 3-minute delay.

However, other species of mysticete have demonstrated their lack of reaction to vessel noise. Sei whales have been observed ignoring the presence of vessels entirely and even passing close to the vessel (Reeves et al., 1998), and North Atlantic right whales tend not to respond to the sounds of oncoming vessels and continue to use habitats in high vessel traffic areas (Nowacek et al., 2004). Studies show that North Atlantic right whales demonstrate little if any reaction to sounds of vessels approaching or the presence of the vessels themselves. This lack of response may be due to habituation to the presence and associated noise of vessels in right whale habitat, or may be due to propagation effects that may attenuate vessel noise near the surface (Nowacek et al., 2004; Terhune & Verboom, 1999).

When baleen whales do respond to vessels, responses can be as minor as a change in breathing patterns (e.g., Baker et al., 1983; Jahoda et al., 2003), or can be evidenced by a decrease in overall presence, as was observed during a construction project in the United Kingdom, when fewer minke whales were observed as vessel traffic increased (Anderwald et al., 2013). Avoidance responses can be as simple as an alteration in swim patterns or direction by increasing speed and heading away from the vessel (Jahoda et al., 2003), or by increasing swim speed, changing direction to avoid, and staying submerged for longer periods of time (Au & Green, 2000). For example, in the presence of approaching vessels, blue whales perform shallower dives accompanied by more frequent surfacing but otherwise do not exhibit strong reactions (Calambokidis et al., 2009c). In another study in Hawaii, humpback whales exhibited two forms of behavioral avoidance: horizontal avoidance (changing direction or speed) when vessels were between 2,000 m and 4,000 m away, and vertical avoidance (increased dive times and change in diving pattern) when vessels were less than 2,000 m away (Baker et al., 1983). Similarly, humpback whales in Australia demonstrated variable responses to whale watching vessels, including both horizontal avoidance, approaching, and changes in dive and surface behavior (Stamation et al., 2010). Humpback whales demonstrated similar responses to tourist vessels in Alaska, with increased respiration rates when the time spent near vessels increased, increased swim speeds and more non-linear movement (Schuler et al., 2019). In addition, while foraging and travelling behavior states were likely to be maintained in the presence of tourist vessels, surface active behavior was more likely to transition to travelling. Humpback whales avoided a Navy vessel by increasing their dive times and decreasing respiration rates at the surface (Smultea et al., 2009). Williamson et al. (2016) specifically looked at close approaches to humpback whales by small research boats for the purposes of tagging. They found that while dive behavior did not change for any groups, some groups did increase their speed and change their course during or right after the approach, but resumed pre-approach speed and heading shortly thereafter. Only mother-calf groups were found to increase their speed during the approach and maintain the increased speed for longer after the approach, but these groups too resumed normal swim speeds after about 40 minutes. It should be noted that there were no responses by any groups that were approached closely but with no attempts at tagging, indicating that the responses were not due to the vessel presence but to the tagging attempt. In addition, none of the observed changes in behavior were outside the normal range of swim speeds or headings for these migrating whales.

Mysticetes have been shown to both increase and decrease calling behavior in the presence of vessel noise. Based on passive acoustic recordings and in the presence of sounds from passing vessels, Melcón et al. (2012) reported that blue whales had an increased likelihood of producing certain types of calls. While humpback whale call repetition and rate has increased in association with high vessel noise (Doyle et al., 2008), a recent study with stringent inclusion criteria found that the probability of humpback whale calls decreased as vessel noise increased (Fournet et al., 2018). The amplitude of humpback whale calls did not change in the absence or presence of vessel noise. However, feeding calls increased amplitude with higher levels of any (i.e., weather or vessel) ambient noise (Fournet et al., 2018). Boat traffic has been a cause of decreased humpback song activity near Brazil (Sousa-Lima & Clark, 2008), and decreased frequency parameters of fin whale calls (Castellote et al., 2012). Bowhead whales avoided the area around icebreaker ship noise and increased their time at the surface and number of blows (Richardson et al., 1995a). Right whales increase the amplitude or frequency of their vocalizations or call at a lower rate in the presence of increased vessel noise (Parks et al., 2007; Parks et al., 2011), and these vocalization changes may persist over long periods if background noise levels remained elevated. Humpback whales increase the source levels of their calls with increased ambient noise levels that include vessel noise, but the probability of calling is also decreased when vessel noise was part of the soundscape (Fournet et al., 2018).

The long-term consequences of vessel noise are not well understood (see Section 3.4.2.1.7, Long-Term Consequences). In a short-term study, minke whales on feeding grounds in Iceland responded to increased whale watching vessel traffic with a decrease in foraging, both during deep dives and at the surface (Christiansen et al., 2013). They also increased their avoidance of the boats while decreasing their respiration rates, likely leading to an increase in their metabolic rates. Christiansen and Lusseau (2015) and Christiansen et al. (2014) followed up this study by modeling the cumulative impacts of whale watching boats on minke whales, but found that although the boats cause temporary feeding disruptions, there were not likely to be long-term consequences as a result. This suggests that short-term responses may not lead to long-term consequences and that over time animals may habituate to the presence of vessel traffic. However, in an area of high whale watch activity, vessels were within 2,000 m of blue whales 70 percent of the time, with a maximum of 8 vessels observed within 400 m of one whale at the same time. This study found reduced surface time, fewer breaths at the surfaced, and shorter dive times when vessels were within 400 m (Lesage et al., 2017). Since blue whales in this area forage 68 percent of the time, and their foraging dive depths are constrained by the location of prey patches, these reduced dive durations may indicate reduced time spent foraging by over 36 percent. In the short term this reduction may be compensated for, but prolonged exposure to vessel traffic could lead to long-term consequences. Using historical records, Watkins (1986) showed that the reactions of four species of mysticetes to vessel traffic and whale watching activities in Cape Cod had changed over the 25-year period examined (1957–1982). Reactions of minke whales changed from initially more positive reactions, such as coming towards the boat or research equipment to investigate, to more uninterested reactions towards the end of the study. Fin whales, the most numerous species in the area, showed a trend from initially more negative reactions, such as swimming away from the boat with limited surfacing, to more uninterested reactions (ignoring), allowing boats to approach within 30 m. Right whales showed little change over the study period, with a roughly equal number of reactions judged to be negative and uninterested; no right whales were noted as having positive reactions to vessels. Humpback whales showed a trend from negative to positive reactions with vessels during the study period. The author concluded that the whales had habituated to the human activities over time (Watkins, 1986).

Overall baleen whale responses to vessel noise and traffic are varied but are generally minor, and habituation or disinterest seems to be the predominant long-term response. When baleen whales do avoid ships they do so by altering their swim and dive patterns to move away from the vessel, but no strong reactions have been observed. In fact, in many cases the whales do not appear to change their behavior at all. This may result from habituation by the whales, but may also result from reduced received levels near the surface due to propagation, or due to acoustic shadowing of the propeller cavitation noise by the ship's hull. Although a lack of response in the presence of a vessel may minimize potential disturbance from passing ships, it does increase the whales' vulnerability to vessel strike, which may be of greater concern for baleen whales than vessel noise (see Section 3.4.2.4, Impacts from Physical Disturbance and Strike).

Odontocetes

Most odontocetes react neutrally to vessels, although both avoidance and attraction behavior have been observed (Hewitt, 1985; Würsig et al., 1998). Würsig et al. (1998) found that Kogia whales and beaked whales were the most sensitive species to vessels, and reacted by avoiding marine mammal survey vessels in 73 percent of sightings, more than any other odontocetes. Avoidance reactions include a decrease in resting behavior or change in travel direction (Bejder et al., 2006a). Incidents of attraction include common, rough-toothed, and bottlenose dolphins bow riding and jumping in the wake of a vessel (Norris & Prescott, 1961; Ritter, 2002; Shane et al., 1986; Würsig et al., 1998). A study of vessel reactions by dolphin communities in the eastern tropical Pacific found that populations that were often the target of tuna purse-seine fisheries (spotted, spinner, and common dolphins) show evasive behavior when approached; however, populations that live closer to shore (within 100 NM; coastal spotted and bottlenose dolphins) that are not set on by purse-seine fisheries tend to be attracted to vessels (Archer et al., 2010). The presence of vessels has also been shown to interrupt feeding behavior in delphinids (Meissner et al., 2015; Pirotta et al., 2015b).

Short-term displacement of dolphins due to tourist boat presence has been documented (Carrera et al., 2008), while longer term or repetitive/chronic displacement for some dolphin groups due to chronic vessel noise has been noted (Haviland-Howell et al., 2007). Delphinid behavioral states also change in the presence of tourist boats that often approach animals, with travel and/or resting increasing and foraging and social behavior decreasing (Cecchetti et al., 2017; Clarkson et al., 2020; Kassamali-Fox et al., 2020; Meissner et al., 2015). Most studies of the behavioral reactions to vessel traffic of bottlenose dolphins have documented at least short-term changes in behavior, activities, or vocalization patterns when vessels are near, although the distinction between vessel noise and vessel movement has not been made clear (Acevedo, 1991; Arcangeli & Crosti, 2009; Berrow & Holmes, 1999; Fumagalli et al., 2018; Gregory & Rowden, 2001; Janik & Thompson, 1996; Lusseau, 2004; Marega et al., 2018; Mattson et al., 2005; Scarpaci et al., 2000). Steckenreuter (2011) found bottlenose dolphin groups to feed less, become more tightly clustered, and have more directed movement when approached to 50 m than groups approached to 150 m or approached in a controlled manner. Guerra et al. (2014) demonstrated that bottlenose dolphins subjected to chronic noise from tour boats responded to boat noise by alterations in group structure and in vocal behavior but also found the dolphins' reactions varied depending on whether the observing research vessel was approaching or moving away from the animals being observed. This demonstrates that the influence of the sound exposure cannot be decoupled from the physical presence of a surface vessel, thus complicating interpretations of the relative contribution of each stimulus to the response. Indeed, the presence of surface vessels, their approach, and speed of approach, seemed to be significant factors in the response of the Indo-Pacific humpback dolphins (Ng & Leung, 2003).

The effects of tourism and whale watching have highly impacted killer whales, such as the Northern and Southern Resident populations. These animals are targeted by numerous small whale watching vessels in the Pacific Northwest and, from 1998 to 2012 during the viewing season, have had an annual monthly average of nearly 20 vessels of various types within 0.5 miles of their location during daytime hours (Clark, 2015; Eisenhardt, 2014; Erbe et al., 2014). These vessels have source levels that ranged from 145 to 169 dB re 1 µPa and produce broadband noise up to 96 kHz. While new regulations on the distance boats had to maintain were implemented, there did not seem to be a concurrent reduction in the received levels of vessel noise, and noise levels were found to increase with more vessels and faster moving vessels (Holt et al., 2017). These noise levels have the potential to result in behavioral disturbance, interfere with communication, and affect the killer whales' hearing capabilities via masking (Erbe, 2002; Veirs et al., 2015). Killer whales foraged significantly less and traveled significantly more when boats were within 100 m of the whales (Kruse, 1991; Lusseau et al., 2009; Trites & Bain, 2000; Williams et al., 2002a; Williams et al., 2009; Williams et al., 2002b). These short-term feeding activity disruptions may have important long-term population-level effects (Lusseau et al., 2009; Noren et al., 2009). As with other delphinids, the reaction of the killer whales to whale watching vessels may be in response to the vessel pursuing them rather than to the noise of the vessel itself, or to the number of vessels in their proximity. Williams et al. (2014b) modeled behavioral responses of killer whales to vessel traffic by looking at their surface behavior relative to the received level of three large classes of ships. The authors found that the severity of the response was largely dependent on seasonal data (e.g., year and month) as well as the animal's prior experience with vessels (e.g., age and sex), and the number of other vessels present, rather than the received level of the larger ships (Williams et al., 2014b).

Sperm whales generally react only to vessels approaching within several hundred m; however, some individuals may display avoidance behavior, such as quick diving (Magalhães et al., 2002; Würsig et al., 1998) or a decrease in time spent at the surface (Isojunno & Miller, 2015). One study showed that after diving, sperm whales showed a reduced timeframe before they emitted the first click than prior to a vessel interaction (Richter et al., 2006). Smaller whale watching and research vessels generate more noise in higher frequency bands and are more likely to approach odontocetes directly, and to spend more time near an individual whale. Azzara et al. (2013) also found a reduction in sperm whale clicks while a vessel was passing, as well as up to a half hour after the vessel had passed. It is unknown whether the whales left the area, ceased to click, or surfaced during this period. However, some of the reduction in click detections may be due to masking of the clicks by the vessel noise, particularly during the closest point of approach.

Little information is available on the behavioral impacts of vessels or vessel noise on beaked whales (Cox et al., 2006), although it seems most beaked whales react negatively to vessels by quick diving and other avoidance maneuvers (Würsig et al., 1998). Limited evidence suggests that beaked whales respond to vessel noise, anthropogenic noise in general, and mid-frequency sonar at similar sound levels (Aguilar de Soto et al., 2006; Tyack et al., 2011; Tyack, 2009). An observation of vocal disruption of a foraging dive by a Cuvier's beaked whale when a large, noisy vessel passed suggests that some types of vessel traffic may disturb foraging beaked whales (Aguilar de Soto et al., 2006). Tyack et al. (2011) noted the result of a controlled exposure to pseudorandom noise suggests that beaked whales would respond to vessel noise at similar received levels to those noted previously for mid-frequency sonar. Pirotta et al. (2012) found that while the distance to a vessel did not change the duration of a foraging dive, the proximity of the vessel may have restricted the movement of the group. The maximum distance at which this change was significant was 5.2 km, with an estimated received level of 135 dB re 1 µPa.

Small dolphins and porpoises may also be more sensitive to vessel noise. Both finless porpoises (Li et al., 2008) and harbor porpoises (Polacheck & Thorpe, 1990) routinely avoid and swim away from large motorized vessels, and harbor porpoises may click less when near large ships (Sairanen, 2014). A resident population of harbor porpoise in Swansea Bay are regularly near vessel traffic, but only 2 percent of observed vessels had interactions with porpoises in one study (Oakley et al., 2017). Of these, 74 percent of the interactions were neutral (no response by the porpoises) while vessels were

10 m–1 km away. Of the 26 percent of interactions in which there was an avoidance response, most were observed in groups of 1–2 animals to fast-moving or steady plane-hulling motorized vessels. Larger groups reacted less often, and few responses were observed to non-motorized or stationary vessels. Another study found that when vessels were within 50 m, harbor porpoises had an 80 percent probability of changing their swimming direction when vessels were fast moving; this dropped to 40 percent probability when vessels were beyond 400 m (Akkaya Bas et al., 2017). These porpoises also demonstrated a reduced proportion of feeding and shorter behavioral bout durations in general, if vessels were in close proximity, 62 percent of the time. Although most vessel noise is constrained to lower frequencies below 1 kHz, at close range vessel noise can extend into mid- and high-frequencies (into the tens of kHz) (Hermannsen et al., 2014; Li et al., 2015); these frequencies are what harbor porpoises are likely responding to, at M-weighted received SPLs with a mean of 123 dB re 1 µPa (Dyndo et al., 2015). Foraging harbor porpoises also have fewer prey capture attempts and have disrupted foraging when vessels pass closely and noise levels are higher (Wisniewska et al., 2018). Hermannsen et al. (2019) estimated that noise in the 16 kHz frequency band resulting from small recreational vessels not equipped with an Automatic Identification System and therefore not included in most vessel noise impact models could be elevated up to 124 dB re 1 µPa and raise ambient levels up to 51 dB; these higher levels were associated with vessel speed and range. Using the threshold levels found by Dyndo et al. (2015) and Wisniewska et al. (2018), these authors determined that recreational vessel noise in the 16 kHz band could cause behavioral responses in harbor porpoises, and that those thresholds were exceeded by 49–85 percent of high noise events.

Odontocetes have been shown to make short-term changes to vocal parameters such as intensity as an immediate response to vessel noise, as well as increase the pitch, frequency modulation, and length of whistling (May-Collado & Wartzok, 2008), with whistle frequency increasing in the presence of low-frequency noise and whistle frequency decreasing in the presence of high-frequency noise (Gospić & Picciulin, 2016). For example, bottlenose dolphins in Portuguese waters decrease their call rates and change the frequency parameters of whistles in the presence of boats (Luís et al., 2014), while dolphin groups with calves increase their whistle rates when tourist boats are within 200 m and when the boats increase their speed (Guerra et al., 2014). Likewise, modification of multiple vocalization parameters was shown in belugas residing in an area known for high levels of commercial traffic. These animals decreased their call rate, increased certain types of calls, and shifted upward in frequency content in the presence of small vessel noise (Lesage et al., 1999). Another study detected a measurable increase in the amplitude of their vocalizations when ships were present (Scheifele et al., 2005). Killer whales are also known to modify their calls during increased noise. For example, the source level of killer whale vocalizations was shown to increase with higher background noise levels associated with vessel traffic (the Lombard effect) (Holt et al., 2008). In addition, calls with a high-frequency component have higher source levels than other calls, which may be related to behavioral state, or may reflect a sustained increase in background noise levels (Holt et al., 2011). On the other hand, long-term modifications to vocalizations may be indicative of a learned response to chronic noise, or of a genetic or physiological shift in the populations. This type of change has been observed in killer whales off the northwestern coast of the United States between 1973 and 2003. This population increased the duration of primary calls once a threshold in observed vessel density (e.g., whale watching) was reached, which is suggested as being a long-term response to increased masking noise produced by the vessels (Foote et al., 2004).

The long-term and cumulative implications of ship sound on odontocetes is largely unknown (National Academies of Sciences Engineering and Medicine, 2017a; National Marine Fisheries Service, 2007a), although some long-term consequences have been reported (Lusseau & Bejder, 2007). Repeated exposure to acoustic and other anthropogenic stimuli has been studied in several cases, especially as related to vessel traffic and whale watching. Common dolphins in New Zealand responded to dolphin-watching vessels by interrupting foraging and resting bouts, and took longer to resume behaviors in the presence of the vessel (Stockin et al., 2008). The authors speculated that repeated interruptions of the dolphins' foraging behaviors could lead to long-term implications for the population. Bejder et al. (2006a) studied responses of bottlenose dolphins to vessel approaches and found stronger and longer lasting reactions in populations of animals that were exposed to lower levels of vessel traffic overall. The authors indicated that lesser reactions in populations of dolphins regularly subjected to high levels of vessel traffic could be a sign of habituation, or it could be that the more sensitive animals in this population previously abandoned the area of higher human activity.

Similar to mysticetes, odontocete responses to vessel noise are varied, although many odontocete species seem to be more sensitive to vessel presence and vessel noise, and these two factors are difficult to tease apart. Some species, in particular killer whales and porpoises, may be sensitized to vessels and respond at further distances and lower received levels than other delphinids. In contrast, many odontocete species also approach vessels to bow ride, indicating either that these species are less sensitive to vessels, or that the behavioral drive to bow ride supersedes any impact of the associated noise. With these broad and disparate responses, it is difficult to assess the impacts of vessel noise on odontocetes.

Pinnipeds

Pinniped reactions to vessels are variable and reports include a wide spectrum of possibilities from avoidance and alert, to cases where animals in the water are attracted, and cases on land where there is lack of significant reaction suggesting habituation to or tolerance of vessels (Richardson et al., 1995b). Specific case reports in Richardson et al. (1995b) vary based on factors such as routine anthropogenic activity, distance from the vessel, engine type, wind direction, and ongoing subsistence hunting. As with reactions to sound reviewed by Southall et al. (2007), pinniped responses to vessels are affected by the context of the situation and by the animal’s experience.

Anderwald et al. (2013) investigated grey seal reactions to an increase in vessel traffic off Ireland’s coast in association with construction activities, and their data suggests the number of vessels had an indeterminate effect on the seals’ presence. Harbor seals haul out on tidewater glaciers in Alaska, and most haulouts occur during pupping season. Blundell & Pendleton (2015) found that the presence of any vessel reduces haulout time, but cruise ships and other large vessels in particular shorten haulout times. Another study of reactions of harbor seals hauled out on ice to cruise ship approaches in Disenchantment Bay, Alaska, revealed that animals are more likely to flush and enter the water when cruise ships approach within 500 m and four times more likely when the cruise ship approaches within 100 m (Jansen et al., 2010). Karpovich et al. (2015) also found that harbor seal heart rates increased when vessels were present during haulout periods, and increased further when vessels approached and animals re-entered the water. Harbor seals responded more to vessels passing by haulout sites in areas with less overall vessel activity, and the model best predicting their flushing behavior included the number of boats, type of boats, and distance to boats. More flushing occurred to non-motorized vessels (e.g., kayaks), likely because they tended to occur in groups rather than as single vessels, and tended to pass closer (25–184 m) to the haulout sites than motorized vessels (55–591 m) (Cates & Acevedo-Gutiérrez, 2017). Jones et al. (2017) modeled the spatial overlap of vessel traffic and grey and harbor seals in the UK, and found most overlap to occur within 50 km of the coast, and high overlap occurring within 5 of 13 grey seal Special Areas of Conservation and within 6 of 12 harbor seal Special Areas of

Conservation. They also estimated received levels of shipping noise and found maximum daily M-weighted cumulative SEL values from 170 to 189 dB, with the upper confidence intervals of those estimates sometimes exceeding TTS values. However, there was no evidence of reduced population size in an of these high overlap areas.

Mikkelsen et al. (2019) used long-term biologgers (DTAGs) on harbor seals and grey seals to opportunistically examine behaviors. The data showed that seals were exposed to vessel noise between 2.2 and 20.5 percent of their time in water. Potential responses to vessels included interruption of resting and foraging behaviors.

Sea Otters

Sea otters that live far inshore and may be exposed to noise from recreational boats and commercial and military ships transiting in and out of port areas. Sea otters have similar in-air hearing sensitivities as pinnipeds (Ghoul & Reichmuth, 2014a, 2014b), and may react in a similar fashion when approached by vessels. However, underwater hearing sensitivities are significantly reduced compared to pinnipeds (Ghoul & Reichmuth, 2014a, 2014b). While reactions to underwater vessel noise may occur, they will have lower overall severity to those of pinnipeds. Sea otters in Monterey, CA that were living in areas of disturbance from human activity such as recreational boating spent more time engaged in travel than resting (Curland, 1997). Sea otters in undisturbed areas spent 5 percent of their time travelling; otters in areas of disturbance due to vessels were shown to spend 13 percent of their time travelling (Curland, 1997). While this may not appear to be a large change in behavior, sea otter dives are very costly and require twice the metabolic energy that phocid seals need to dive; therefore sea otters may not dive or travel far in response to disturbance, as they already require long periods of rest at the surface to counterbalance the high cost of foraging at sea (Yeates et al., 2007). For example, when a single air gun vessel passed a large raft of otters, several otters were mildly alarmed (e.g., rolled over on their sides or bellies and looked intently at the vessel as it approached) but did not leave the raft. However, they reacted to the vessel every time it passed, even though the air gun was only operational for two of the four passes. This indicates that otters were either responding to the loud airborne sounds of the boat engines and compressor, or to the close approach of the vessel itself, rather than the seismic sounds (Reidman, 1983). However, sea otters may habituate quickly. Even when purposefully harassed in an effort to cause a behavioral response, sea otters generally moved only a short distance (100 to 200 m) before resuming normal activity, and nearby boats, nets, and floating oil containment booms were sometimes an attractant (Davis et al., 1988). Although Barrett (2019) found that sea otters have a high metabolic rate and are at risk of increased energetic costs when disturbed, there was less than a 10 percent chance of disturbance when small vessels were more 54 m away from sea otters.

Behavioral Reactions to Aircraft Noise

The following paragraphs summarize what is known about the reaction of various marine mammal species to overhead flights of many types of fixed-wing aircraft and rotary-wing aircraft (i.e., helicopters), as well as unmanned aerial systems. Thorough reviews of the subject and available information is presented in Richardson et al. (1995b) and elsewhere (e.g., Efroymson et al., 2001; Holst et al., 2011; Luksenburg & Parsons, 2009; Smith et al., 2016). The most common responses of cetaceans to overflights were short surfacing durations, abrupt dives, and percussive behavior (breaching and tail slapping) (Nowacek et al., 2007). Other behavioral responses such as flushing and fleeing the area of the source of the noise have also been observed (Holst et al., 2011; Manci et al., 1988). Richardson et al. (1995b) noted that marine mammal reactions to aircraft overflight largely consisted of opportunistic and anecdotal observations lacking clear distinction between reactions potentially caused by the noise of the aircraft and the visual cue an aircraft presents. In addition, it was suggested that variations in the responses noted were due to generally other undocumented factors associated with overflights (Richardson et al., 1995b). These factors could include aircraft type (single engine, multi-engine, jet turbine), flight path (altitude, centered on the animal, off to one side, circling, level and slow), environmental factors (e.g., wind speed, sea state, cloud cover), and locations where native subsistence hunting continues and animals are more sensitive to anthropogenic impacts, including the noise from aircraft. Erbe et al. (2018) measured airplane noise levels underwater at sites about 1 and 10 km from an airport runway and found median noise levels up to 117 dB re 1 µPa and 10 kHz at the close site, and up to 91 dB re 1 µPa and 2 kHz at the more distant site; both would be audible to a number of marine mammals at those levels and frequencies. Christiansen et al. (2016b) measured the in-air and underwater noise levels of two unmanned aerial vehicles, and found that in air, the broadband source levels were around 80 dB re 20 µPa, while at a meter underwater received levels were 95−100 dB re 1 µPa when the vehicle was only 5−10 m above the surface, and were not quantifiable above ambient noise levels when the vehicle was higher. Therefore, if an animal is near the surface and the unmanned aerial vehicle is low, it may be detected, but in most cases these vehicles are operated at much higher altitudes (e.g., over 30 m) and so are not likely to be heard.

The impact of aircraft overflights is one of the least well-known sources of potential behavioral response by any species or taxonomic group, and so many generalities must be made based on the little data available. There is some data for each taxonomic group; taken together it appears that in general, marine mammals have varying levels of sensitivity to overflights depending on the species and context.

Mysticetes

Mysticetes either ignore or occasionally dive in response to aircraft overflights (Koski et al., 1998). Richardson (1985; 1995b) found no evidence that single or occasional aircraft flying above mysticetes causes long-term displacement of these mammals.

Bowhead whales in the Beaufort Sea exhibited a transient behavioral response to fixed-wing aircraft and vessels. Reactions were frequently observed at less than 1,000 ft. above sea level, infrequently observed at 1,500 ft., and not observed at all at 2,000 ft. (Richardson et al., 1985). Bowhead whales reacted to helicopter overflights by diving, breaching, changing direction or behavior, and altering breathing patterns. Behavioral reactions decreased in frequency as the altitude of the helicopter increased to 150 m or higher. The bowheads exhibited fewer behavioral changes than did the odontocetes in the same area (Patenaude et al., 2002). It should be noted that bowhead whales in this study may have more acute responses to anthropogenic activity than many other marine mammals since these animals were presented with restricted egress due to limited open water between ice floes. Additionally, these animals are hunted by Alaska Natives, which could lead to animals developing additional sensitivity to human noise and presence.

A pilot study was conducted on the use of unmanned aerial systems to observe bowhead whales; flying at altitudes between 120 to 210 m above the surface, no behavioral responses were observed in any animals (Koski et al., 2015; Koski et al., 1998). Similarly, Christiansen et al. (2016a) did not observe any responses to an unmanned aerial vehicle flown 30–120 m above the water when taking photos of humpback whales to conduct photogrammetry and assess fitness. In a follow-on study, Christiansen et al. (2020) also did not observe any behavioral response in the form of changes in swim speeds, respiration rates, turning angles, or interbreath intervals to an unmanned aerial vehicle flown over 10 southern right whale mother-calf pairs. In addition, some of the animals were equipped with digital acoustic recording tags to measure the sound of the unmanned aerial vehicle; the received levels in the

100–1,500 Hz band were 86 ± 4 dB re 1 µPa, very similar to ambient noise levels measured at 81 ± 7 dB in the same frequency band. Acevedo-Whitehouse et al. (2010) successfully maneuvered a remote controlled helicopter over large baleen whales to collect samples of their blows, with no more avoidance behavior than noted for typical photo-identification vessel approaches. These vehicles are much smaller and quieter than typical aircraft and so are less likely to cause a behavioral response, although they may fly at much lower altitudes (Smith et al., 2016).

Odontocetes

Variable responses to aircraft have been observed in toothed whales, though overall little change in behavior has been observed during flyovers. Some toothed whales dove, slapped the water with their flukes or flippers, or swam away from the direction of the aircraft during overflights; others did not visibly react (Richardson et al., 1995b). Würsig et al. (1998) found that beaked whales were the most sensitive cetacean and reacted by avoiding marine mammal survey aircraft in 89 percent of sightings and at more than twice the rate as Kogia whales, which was the next most reactive of the odontocetes in 39 percent of sightings; these are the same species that were sensitive to vessel traffic.

During standard marine mammal surveys at an altitude of 750 ft., some sperm whales remained on or near the surface the entire time the aircraft was in the vicinity, while others dove immediately or a few minutes after being sighted. Other authors have corroborated the variability in sperm whales' reactions to fixed-wing aircraft or helicopters (Green et al., 1992; Richter et al., 2006; Richter et al., 2003; Smultea et al., 2008; Würsig et al., 1998). In one study, sperm whales showed no reaction to a helicopter until they encountered the downdrafts from the rotors (Richardson et al., 1995b). A group of sperm whales responded to a circling aircraft (altitude of 800 to 1,100 ft.) by moving closer together and forming a defensive fan-shaped semicircle, with their heads facing outward. Several individuals in the group turned on their sides, apparently to look up toward the aircraft (Smultea et al., 2008). Whale watching aircraft (fixed-wing airplanes and helicopters) apparently caused sperm whales to turn more sharply but did not affect blow interval, surface time, time to first click, or the frequency of aerial behavior (Richter et al., 2003).

Smaller delphinids generally react to overflights either neutrally or with a startle response (Würsig et al., 1998). The same species that show strong avoidance behavior to vessel traffic (Kogia species and beaked whales) show similar reactions to aircraft (Würsig et al., 1998). Beluga whales reacted to helicopter overflights by diving, breaching, changing direction or behavior, and altering breathing patterns to a greater extent than mysticetes in the same area (Patenaude et al., 2002). These reactions increased in frequency as the altitude of the helicopter dropped below 150 m. A change in travel direction was noted in a group of pilot whales as the aircraft circled while conducting monitoring (State of Hawaii, 2015). No changes in group cohesion or orientation behavior were observed for groups of Risso's dolphins, common dolphins, or killer whales when a survey airplane flew at altitudes of 213–610 m, but this may be due to the plane maintaining lateral distances greater than 500 m in all (Smultea & Lomac-MacNair, 2016).

Much like mysticetes, odontocetes have demonstrated no responses to unmanned aerial systems. For example, Durban et al. (2015) conducted photogrammetry studies of killer whales using a small helicopter flown 35–40 m above the animals with no disturbance noted. However, it is possible that odontocete responses could increase with use at reduced altitudes, due either to noise or the shadows created by the vehicle (Smith et al., 2016). Bottlenose dolphins responded to a small portion of unmanned aerial vehicles by briefly orienting when the vehicle was relatively close (10–30 m high), but in most cases did not respond at all (Ramos et al., 2018).

Pinnipeds

Richardson et al. (1995b) noted that responsiveness to aircraft overflights generally was dependent on the altitude of the aircraft, the abruptness of the associated aircraft sound, and life cycle stage (breeding, molting, etc.). In general pinnipeds are unresponsive to overflights, and may startle, orient towards the sound source or increase vigilance, or may briefly re-enter the water, but typically remain hauled out or immediately return to their haulout location (Blackwell et al., 2004; Gjertz & Børset, 1992). Adult females, calves and juveniles are more likely to enter the water than males, and stampedes resulting in mortality to pups (by separation or crushing) can occur when disturbance is severe, although they are rare (Holst et al., 2011). Responses may also be dependent on the distance of the aircraft. For example, reactions of walruses on land varied in severity and included minor head raising at a distance of 2.5 km, orienting toward or entering the water at less than 150 m and 1.3 km in altitude, to full flight reactions at horizontal ranges of less than 1 km at altitudes as high as 1,000–1,500 m (Richardson et al., 1995b).

Helicopters are used in studies of several species of seals hauled out and are considered an effective means of observation (Bester et al., 2002; Gjertz & Børset, 1992), although they have been known to elicit behavioral reactions such as fleeing (Hoover, 1988). For California sea lions and Steller sea lions at a rocky haulout off Crescent City in northern California, helicopter approaches to landing sites typically caused the most severe response of diving into the water (National Oceanic and Atmospheric Administration, 2010). Responses were also dependent on the species, with Steller sea lions being more sensitive and California sea lions more tolerant. Depending on the time between subsequent approaches, animals hauled out in between and fewer animals reacted upon subsequent exposures (National Oceanic and Atmospheric Administration, 2010).

Pinniped reactions to rocket launches and overflight at San Nicolas Island were studied from August 2001 to October 2008 (Holst et al., 2011). California sea lions startled and increased vigilance for up to two minutes after a rocket overflight, with some individuals moving down the beach or returning to the water. Northern elephant seals showed little reaction to any overflight. Harbor seals had the most pronounced reactions of the three species observed with most animals within approximately 4 km of the rocket trajectory leaving their haulout sites for the water and not returning for several hours. The authors concluded that the effects of the rocket launches were minor with no effects on local populations evidenced by the growing populations of pinnipeds on San Nicolas Island (Holst et al., 2011).

Pinnipeds may be more sensitive to unmanned aerial systems, especially those flying at low altitudes, due to their possible resemblance to predatorial birds (Smith et al., 2016), which could lead to flushing behavior (Olson, 2013). Responses may also vary by species, age class, behavior, and habituation to other anthropogenic noise, as well as by the type, size, and configuration of unmanned aerial vehicle used (Pomeroy et al., 2015). However, in general pinnipeds have demonstrated little to no response to unmanned aerial systems, with some orienting towards the vehicle, other alerting behavior, or short-term flushing possible (Moreland et al., 2015; Sweeney et al., 2015).

Sea Otters

Sea otters spend approximately 80 percent of their time on the surface of the water (Curland, 1997) with their heads above the surface, and will most likely be exposed to noise from aircraft. Recordings of underwater noise produced by helicopter overflights did not appear to affect sea otter foraging behavior, foraging success, or daily activity patterns when projected underwater 1–1.5 km from a group of otters in Lobos Cove (Reidman, 1983). Sea otters have similar in-air hearing sensitivities as pinnipeds

(Ghoul & Reichmuth, 2014a, 2014b), and may react in a similar fashion when exposed to aircraft noise. Pinnipeds in general are unresponsive but may react depending on the altitude of the aircraft or the abruptness of the associated sound (Richardson et al., 1995b), with reactions ranging from unresponsiveness to flushing into the water location (Blackwell et al., 2004; Gjertz & Børset, 1992). Sea otters may dive below the surface of the water or flush into the water to avoid aircraft noise. However, sea otter dives are very costly and require twice the metabolic energy that phocid seals need to dive; therefore sea otters may not dive or travel so readily in response to disturbance, as they already require long periods of rest at the surface to counterbalance the high cost of foraging at sea (Yeates et al., 2007). So far, there has been no evidence that any aircraft has had adverse effects on a well-monitored translocated colony of sea otters at San Nicolas Island, which has a landing field operated by the U.S. Navy (U.S. Fish and Wildlife Service, 2012, 2015).

Behavioral Reactions to Impulsive Noise

Impulsive signals (i.e., weapon noise and explosions), particularly at close range, have a rapid rise time and higher instantaneous peak pressure than other signal types, making them more likely to cause startle responses or avoidance responses. However, at long distances the rise time increases as the signal duration lengthens (similar to a "ringing" sound), making the impulsive signal more similar to a non-impulsive signal. Behavioral reactions from explosive sounds are likely to be similar to reactions studied for other impulsive sounds, such as those produced by air guns and impact pile driving. Data on behavioral responses to impulsive sound sources are limited across all marine mammal groups, with only a few studies available for mysticetes, odontocetes, pinnipeds, and sea otters. Most data have come from seismic surveys that occur over long durations (e.g., on the order of days to weeks), and typically utilize large multi-air gun arrays that fire repeatedly. While seismic data provide the best available science for assessing behavioral responses to impulsive sounds by marine mammals, it is likely that these responses represent a worst-case scenario as compared to responses to explosives used in Navy activities, which would typically consist of single impulses or a cluster of impulses, rather than long-duration, repeated impulses.

Mysticetes

Baleen whales have shown a variety of responses to impulsive sound sources, including avoidance, attraction to the source, reduced surface intervals, altered swimming behavior, and changes in vocalization rates (Gordon et al., 2003; McCauley et al., 2000; Richardson et al., 1985; Southall et al., 2007). Studies have been conducted on many baleen whale species, including gray, humpback, blue, fin and bowhead whales; it is assumed that these responses are representative of all baleen whale species. The behavioral state of the whale seems to be an integral part of whether or not the animal responds and how they respond, as does the location and movement of the sound source, more than the received level of the sound.

Migratory behavior seems to lead to a higher likelihood of response, with some species demonstrating more sensitivity than others do. For example, migrating gray whales showed avoidance responses to seismic vessels at received levels between 164 and 190 dB re 1 µPa (Malme et al., 1986, 1988). Similarly, migrating humpback whales showed avoidance behavior at ranges of 5–8 km from a seismic array during observational studies and controlled exposure experiments in one Australian study (McCauley et al., 1998), and in another Australian study decreased their dive times and reduced their swimming speeds (Dunlop et al., 2015). However, when comparing received levels and behavioral responses using ramp-up versus a constant noise level of air guns, humpback whales did not change their dive behavior but did deviate from their predicted heading and decreased their swim speeds (Dunlop et al., 2016). In addition, the whales demonstrated more course deviation during the constant source trials but reduced travel speeds more in the ramp-up trials; in either case there was no dose-response relationship with the received level of the air gun noise, and similar responses were observed in control trials with vessel movement but no air guns so some of the response was likely due to the presence of the vessel and not the received level of the air guns. When looking at the relationships between proximity, received level, and behavioral response, Dunlop et al. (2017) used responses to two different air guns and found responses occurred more towards the smaller, closer source than to the larger source at the same received level, demonstrating the importance of proximity. Responses were found to be more likely when the source was within 3 km or above 140 dB re 1 µPa, although responses were variable and some animals did not respond at those values while others responded below them. In addition, responses were generally small, with course deviations of only around 500 m, and short-term (Dunlop et al., 2017). McDonald et al. (1995) tracked a blue whale with seafloor seismometers and reported that it stopped vocalizing and changed its travel direction at a range of 10 km from the seismic vessel (estimated received level 143 dB re 1 µPa peak-to-peak). Bowhead whales seem to be the most sensitive species, perhaps due to a higher overlap between bowhead whale distribution and seismic surveys in Arctic and sub-Arctic waters, as well as a recent history of being hunted. While most bowhead whales did not show active avoidance until within 8 km of seismic vessels (Richardson et al., 1995b), some whales avoided vessels by more than 20 km at received levels as low as 120 dB re 1 µPa. Additionally, Malme et al. (1988) observed clear changes in diving and breathing patterns in bowheads at ranges up to 73 km from seismic vessels, with received levels as low as 125 dB re 1 µPa. Bowhead whales may also avoid the area around seismic surveys, from 6 to 8 km (Koski and Johnson 1987, as cited in Gordon et al., 2003) out to 20 or 30 km (Richardson et al., 1999). However, work by Robertson (2014) supports the idea that behavioral responses are contextually dependent, and that during seismic operations bowhead whales may be less “available” for counting due to alterations in dive behavior but that they may not have left the area after all.

In contrast, noise from seismic surveys was not found to impact feeding behavior or exhalation rates in western gray whales while resting or diving off the coast of Russia (Gailey et al., 2007; Yazvenko et al., 2007); however, the increase in vessel traffic associated with the surveys and the proximity of the vessels to the whales did affect the orientation of the whales relative to the vessels and shortened their dive-surface intervals (Gailey et al., 2016). Todd et al. (1996) found no clear short-term behavioral responses by foraging humpbacks to explosions associated with construction operations in Newfoundland but did see a trend of increased rates of net entanglement closer to the noise source, possibly indicating a reduction in net detection associated with the noise through masking or TTS. Distributions of fin and minke whales were modeled with a suite of environmental variables along with the occurrence or absence of seismic surveys, and no evidence of a decrease in sighting rates relative to seismic activity was found for either species (Vilela et al., 2016). Their distributions were driven entirely by environmental variables, particularly those linked to prey including warmer sea surface temperatures, higher chlorophyll-a values, and higher photosynthetically available radiation (a measure of primary productivity). Sighting rates based on over 8,000 hours of baleen and toothed whale survey data were compared on regular vessel surveys versus both active and passive periods of seismic surveys (Kavanagh et al., 2019). Models of sighting numbers were developed, and it was determined that baleen whale sightings were reduced by 88 percent and 87 percent during active and inactive phases of seismic surveys, respectively, compared to regular surveys. These results seemed to occur regardless of geographic location of the survey; however, when only comparing active vs. inactive periods of seismic surveys, the geographic location did seem to affect the change in sighting rates.

Vocal responses to seismic surveys have been observed in a number of baleen whale species, including a cessation of calling, a shift in frequency, increases in amplitude or call rate, or a combination of these strategies. Blue whale feeding/social calls were found to increase when seismic exploration was underway, with seismic pulses at average received SELs of 131 dB re 1 μPa^2s (Di Lorio & Clark, 2010), a potentially compensatory response to increased noise level. Responses by fin whales to a 10-day seismic survey in the Mediterranean Sea included possible decreased 20-Hz call production and movement of animals from the area based on lower received levels and changes in bearings (Castellote et al., 2012). However, similarly distant seismic surveys elicited no apparent vocal response from fin whales in the mid-Atlantic Ocean; instead, Nieukirk et al. (2012) hypothesized that 20-Hz calls may have been masked from the receiver by distant seismic noise. Models of humpback whale song off Angola showed significant seasonal and diel variation, but also showed a decrease in the number of singers with increasing received levels of air gun pulses (Cerchio et al., 2014). Bowhead whale calling rates decreased significantly at sites near seismic surveys (41–45 km) where median received levels were between 116 and 129 dB re 1 µPa, and did not decrease at sites further from the seismic surveys (greater than 104 km) where median received levels were 99–108 dB re 1 µPa (Blackwell et al., 2013). In fact, bowhead whale calling rates increased at the lower received levels, began decreasing at around 127 dB re 1 μPa^2s cumulative SEL, and ceased altogether at received levels over 170 dB re 1 μPa^2s cumulative SEL (Blackwell et al., 2015). Similar patterns were observed for bowhead vocalizations in the presence of tonal sounds associated with drilling activities, and were amplified in presence of both the tonal sounds and air gun pulses (Blackwell et al., 2017).

Mysticetes seem to be the most sensitive taxonomic group of marine mammals to impulsive sound sources, with possible avoidance responses occurring out to 30 km and vocal changes occurring in response to sounds over 100 km away. However, responses appear to be behaviorally mediated, with most avoidance responses occurring during migration behavior and little observed response during feeding behavior. These response patterns are likely to hold true for Navy impulsive sources; however, Navy impulsive sources would largely be stationary (e.g., explosives fired at a fixed target), and short-term (on the order of hours rather than days or weeks) than were found in these studies and so responses would likely occur in closer proximity or not at all.

Odontocetes

Few data are available on odontocete responses to impulsive sound sources, with only a few studies on responses to seismic surveys, pile driving and construction activity available. However, odontocetes appear to be less sensitive to impulsive sound than mysticetes, with responses occurring at much closer distances. This may be due to the predominance of low-frequency sound associated with these sources that propagates long distances and overlaps with the range of best hearing for mysticetes but is below that range for odontocetes. The exception to this is the harbor porpoise, which has been shown to be highly sensitive to most sound sources, avoiding both stationary (e.g., pile driving) and moving (e.g., seismic survey vessels) impulsive sound sources out to approximately 20 km (e.g., Haelters et al., 2014; Pirotta et al., 2014). However, even this response is short-term, with porpoises returning to the area within hours after the cessation of the noise.

Madsen et al. (2006) and Miller et al. (2009) tagged and monitored eight sperm whales in the Gulf of Mexico exposed to seismic air gun surveys. Sound sources were from approximately 2 to 7 NM away from the whales, and received levels were as high as 162 dB SPL re 1 µPa (Madsen et al., 2006). The whales showed no horizontal avoidance, however one whale rested at the water's surface for an extended period of time until air guns ceased firing (Miller et al., 2009). While the remaining whales continued to execute foraging dives throughout exposure, tag data suggested there may have been subtle effects of noise on foraging behavior (Miller et al., 2009). Similarly, Weir (2008) observed that seismic air gun surveys along the Angolan coast did not significantly reduce the encounter rate of sperm whales during the 10-month survey period, nor were avoidance behaviors to air gun impulsive sounds observed. In contrast, Atlantic spotted dolphins did show a significant, short-term avoidance response to air gun impulses within approximately 1 km of the source (Weir, 2008). The dolphins were observed at greater distances from the vessel when the air gun was in use, and when the air gun was not in use they readily approached the vessel to bow ride. Kavanagh et al. (2019) also found that toothed whales were more adverse to active airguns, as sightings of several species of odontocetes were reduced by 53 percent and 29 percent during active and inactive phases of seismic surveys, respectively, compared to regular surveys.

Captive bottlenose dolphins sometimes vocalized or were reluctant to return to the test station after exposure to single impulses from a seismic water gun (Finneran et al., 2002). When exposed to multiple impulses from a seismic air gun, some dolphins turned their heads away from the sound source just before the impulse, showing that they could anticipate the timing of the impulses and perhaps reduce the received level (Finneran et al., 2015). During construction (including the blasting of old bastions) of a bridge over a waterway commonly used by the Tampa Bay, FL stock of bottlenose dolphins, the use of the area by females decreased while males displayed high site fidelity and continued using the area, perhaps indicating differential habitat uses between the sexes (Weaver, 2015).

A study was conducted on the response of harbor porpoises to a seismic survey using aerial surveys and C-PODs (an autonomous recording device that counts odontocete clicks); the animals appeared to have left the area of the survey, and decreased their foraging activity within 5–10 km, as evidenced by both a decrease in vocalizations near the survey and an increase in vocalizations at a distance (Pirotta et al., 2014; Thompson et al., 2013). However, the animals returned within a day after the air gun operation ceased, and the decrease in occurrence over the survey period was small relative to the observed natural seasonal decrease compared to the previous year. A number of studies (Brandt et al., 2011; Dähne et al., 2014; Haelters et al., 2014; Thompson et al., 2010; Tougaard et al., 2005; Tougaard et al., 2009) also found strong avoidance responses by harbor porpoises out to 20 km during pile driving; however, all studies found that the animals returned to the area after the cessation of pile driving. When bubble curtains were deployed around a pile driving, the avoidance distance appeared to be reduced to half that distance (12 km), and the response only lasted about five hours rather than a day before the animals returned to the area (Dähne et al., 2017).

However, not all harbor porpoise behavioral response studies ended in habitat displacement. Sarnocińska et al. (2020) also placed C-PODs near oil and gas platforms and control sites 15 km away and found a dose-response effect, with the lowest amount of porpoise activity closest to the seismic vessel ($SEL_{single\ shot}$ = 155 dB re 1 µPa^2-s) and then increasing porpoise activity out to 8–12 km, outside of which levels were similar to baseline. Distance to the seismic vessel was a better model predictor of porpoise activity than sound level. Despite these smaller-scale responses, a large-scale response was not detected, and overall porpoise activity in the seismic area was similar to the control stations; this may indicate that the porpoises were moving around the seismic area to avoid the ship but not leaving the area entirely (Sarnocińska et al., 2020).

When exposing a captive harbor porpoise to impact pile driving sounds, Kastelein et al. (2013b) found that above 136 dB re 1 µPa (zero-to-peak) the animal's respiration rates increased, and at higher levels it jumped more frequently. Bergstrom et al. (2014) found that although there was a high likelihood of acoustic disturbance during wind farm construction (including pile driving), the impact was short-term. Graham et al. (2017) assessed the occurrence of bottlenose dolphins and harbor porpoises over different area and time scales with and without impact and vibratory pile driving. While there were fewer hours with bottlenose dolphin detections and reduced detection durations within the pile driving area and increased detection durations outside the area, the effects sizes were small, and the reduced harbor porpoise encounter duration was attributed to seasonal changes outside the influence of the pile driving. However, received levels in this area were lower due to propagation effects than in the other areas described above, which may have led to the lack of or reduced response. In another impulsive pile driving study, Graham et al. (2019) found that the distance at which behavioral responses were probable decreased over the course of the construction project, suggesting habituation to pile-driving noise in the local harbor porpoise population.

Odontocete behavioral responses to impulsive sound sources are likely species- and context-dependent, with most species demonstrating little to no apparent response. Responses might be expected within close proximity to a noise source, under specific behavioral conditions such as females with offspring, or for sensitive species such as harbor porpoises.

Pinnipeds

A review of behavioral reactions by pinnipeds to impulsive noise can be found in Richardson et al. (1995b) and Southall et al. (2007). Blackwell et al. (2004) observed that ringed seals exhibited little or no reaction to pipe-driving noise with mean underwater levels of 157 dB re 1 µPa and in-air levels of 112 dB re 20 µPa, suggesting that the seals had habituated to the noise. In contrast, captive California sea lions avoided sounds from an underwater impulsive source at levels of 165–170 dB re 1 µPa (Finneran et al., 2003b). Harbor and grey seals were also observed to avoid a seismic air gun by rapidly swimming away, and ceased foraging during exposure, but returned to normal behavior afterwards (Thompson et al. 1998, cited in Gordon et al., 2003). In another study, few responses were observed by New Zealand fur seals to a towed air gun array operating at full power; rather, when responses were observed it seemed to be to the physical presence of the vessel and tow apparatus, and these only occurred when the vessel was within 200 m and sometimes as close as 5 m (Lalas & McConnell, 2016). Captive Steller sea lions were exposed to a variety of tonal, sweep, impulsive and broadband sounds to determine what might work as a deterrent from fishing nets. The impulsive sound had a source level of 120 dB re 1 µPa at 1 m, and caused the animals to haul out and refuse to eat fish presented in a net (Akamatsu et al., 1996). Steller sea lions exposed to in-air explosive blasts increased their activity levels and often re-entered the water when hauled out (Demarchi et al., 2012). However, these responses were short-lived and within minutes, the animals had hauled out again, and there were no lasting behavioral impacts in the days following the blasts.

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

Pinnipeds may be the least sensitive taxonomic group to most noise sources, although some species may be more sensitive than others, and are likely to only respond to loud impulsive sound sources at close ranges by startling, jumping into the water when hauled out, or even cease foraging, but only for brief periods before returning to their previous behavior (e.g., (Southall et al., 2007)). Pinnipeds may even experience TTS (see Section 3.4.2.2.1.2, Hearing Loss) before exhibiting a behavioral response (Southall et al., 2007).

Sea Otters

There are few available studies on responses of sea otters to impulsive sounds. A playback study of multiple and single air guns had no significant impact on sea otters in California. During the multiple air gun exposures, otters rested 1 percent more and foraged 1 percent less. They were successful at obtaining prey during 84 percent of their foraging dives when the air gun vessel was 50 NM away, and the success rate only decreased by 5 percent when the multiple air gun vessel moved closer (0.5 NM away). Overall, foraging and dive behaviors remained undisturbed, as did the density and distribution of sea otters in the area. This study caveats that the data were collected under rough weather conditions which could have affected the otters' perception of the seismic sounds. In addition, otters kept close to shore in relatively sheltered coves (Reidman, 1983).

During the single air gun experiment, the air gun ship approached a raft of otters (at a minimum of 730 m), and several otters were mildly alarmed (e.g., rolled over on their sides or bellies and looked intently at the vessel as it approached) but did not leave the raft. Of the four times the vessel passed the group of otters, the air gun was operational during only two of the transects. However, the otters reacted to the vessel every time it passed, indicating that otters were either responding to the loud airborne sounds of the boat engines and compressor, or to the close approach of the vessel itself, rather than the seismic sounds (Reidman, 1983).

In a follow-up study, Riedman (1984) monitored sea otter reactions to drilling platform sounds and airgun firing projected from a source vessel 0.9 to 1.6 km away from groups of sea otters. No behavioral reactions or movements were observed in 14 days of observations with 15–38 individual sea otters present on any given day. Sound pressure levels from the airgun were reported as 166 dB re 1 µPa at 1.1 km, which means that two otters may have been subjected to levels greater than this at ranges of 900 m on the one day the pair foraged closer to the air gun ship for one hour. Most of the otters would have been subjected to just under this level, since the majority of otters foraged 1.3–1.6 m away from the sound sources, and propagation loss due to distance and the kelp environment needs to be considered. In a survey of the local coastline, no change in numbers of sea otters was evident between just prior to the sound stimuli and on day 10 of the emissions. No changes in feeding dive times or feeding success was seen during the study either.

When conducting impact and vibratory pile driving for the Parsons Slough estuarine restoration, the Elkhorn Slough National Estuarine Research Reserve (2011) recorded the abundance and behavior of sea otters in the area. Disturbances within 30 m of the pile driving site included otters raising their heads, swimming away without startling, or startle diving. Usually only single adult males with an established territory that included the construction site traveled within 30 m. Otters further away (> 180 m) were observed swimming away with startling, including mother-pup pairs. However, sea otter behavioral disturbances 30–180 m away from the pile driving site were difficult to tease apart from the impacts of pedestrian vessels and other construction activities.

Sea otters spend approximately 80 percent of their time on the surface of the water (Curland, 1997) with their heads above the surface, which reduces their exposure to underwater sounds. They require long periods of undisturbed rest at the surface to counterbalance high metabolic costs associated with forging at sea (Yeates et al., 2007). If reactions to Navy impulsive noise were to occur, they may be similar to those of pinnipeds, which show temporary avoidance responses or cessation of foraging behavior (Thompson et al. 1998, cited in Gordon et al., 2003). However, underwater hearing sensitivities are significantly reduced in sea otters when compared to pinnipeds (Ghoul & Reichmuth, 2014a, 2014b), so reactions may not be as strong, if they occur at all.

3.4.2.1.1.6 Stranding

When a marine mammal (alive or dead) swims or floats onto shore and becomes beached or incapable of returning to sea, the event is termed a "stranding" (Geraci et al., 1999; Geraci & Lounsbury, 2005; Perrin & Geraci, 2002). A stranding can also occur away from the shore if the animal is unable to cope in its present situation (e.g., disabled by a vessel strike, out of habitat) (Geraci & Lounsbury, 2005). Specifically, under U.S. law, a stranding is an event in the wild in which: " (A) a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance" (16 U.S.C. section 1421h).

Marine mammals are subjected to a variety of natural and anthropogenic factors, acting alone or in combination, which may cause a marine mammal to strand (Geraci et al., 1999; Geraci & Lounsbury, 2005). Natural factors related to strandings include limited food availability or following prey inshore, predation, disease, parasitism, natural toxins, echolocation disturbance, climatic influences, solar activity-based disruption of magnetoreception, and aging (Bradshaw et al., 2006; Culik, 2004; Geraci et al., 1999; Geraci & Lounsbury, 2005; Granger et al., 2020; Huggins et al., 2015; National Research Council, 2006; Perrin & Geraci, 2002; Walker et al., 2005). Anthropogenic factors include pollution (Hall et al., 2006; Jepson et al., 2005), vessel strike (Geraci & Lounsbury, 2005; Laist et al., 2001), fisheries interactions (Read et al., 2006), entanglement (Baird & Gorgone, 2005; Saez et al., 2013; Saez et al., 2012), human activities (e.g., feeding, gunshot) (Dierauf & Gulland, 2001; Geraci & Lounsbury, 2005), and noise (Cox et al., 2006; National Research Council, 2003; Richardson et al., 1995b). For some stranding events, environmental factors (e.g., ocean temperature and wind speed and geographic conditions) can be utilized in predictive models to aid in understanding why marine mammals strand in certain areas more than others (Berini et al., 2015). Decomposition, buoyancy, scavenging by other marine species, wave damage and other oceanic conditions complicate the assessment of marine mammal carcasses (Moore et al., 2020). In most instances, even for the more thoroughly investigated strandings involving post-stranding data collection and necropsies, the cause (or causes) for strandings remains undetermined.

Along the coasts of the continental United States and Alaska between 2001 and 2009, there were on average approximately 12,545 cetacean strandings and 39,104 pinniped strandings (51,649 total) per year (National Marine Fisheries Service, 2016b). Several mass strandings (strandings that involve two or more individuals of the same species, excluding a single mother-calf pair) that have occurred over the past two decades have been associated with anthropogenic activities that introduced sound into the marine environment such as naval operations and seismic surveys. U.S. Navy sonar has been identified as a contributing factor in a small number of strandings; none of these have occurred in the Study Area.

Sonar use during exercises involving the U.S. Navy has been identified as a contributing cause or factor in five specific mass stranding events: Greece in 1996; the Bahamas in March 2000; Madeira Island, Portugal in 2000; the Canary Islands in 2002, and Spain in 2006 (Cox et al., 2006; Fernandez, 2006; U.S.

Department of the Navy, 2017e), as described in the Navy's technical report titled *Marine Mammal Strandings Associated with U.S. Navy Sonar Activities* (U.S. Department of the Navy, 2017e).These five mass strandings have resulted in about 40 known cetacean deaths consisting mostly of beaked whales and with close linkages to mid-frequency active sonar activity. In these circumstances, exposure to non-impulsive acoustic energy was considered a potential indirect cause of death of the marine mammals (Cox et al., 2006). Factors that were associated with these beaked whales strandings included steep bathymetry, multiple hull-mounted platforms using sonar simultaneously, constricted channels, and strong surface ducts. An in-depth discussion of these strandings and these factors is in the technical report titled *Marine Mammal Strandings Associated with U.S. Navy Sonar Activities* (available at www.nwtteis.com). Strandings of other marine mammal species have not been as closely linked to sonar exposure, but rather, have typically been attributed to natural or other anthropogenic factors. The Navy has reviewed training requirements, standard operating procedures, and potential mitigation measures, and has implemented changes to reduce the potential for acoustic related strandings to occur in the future. Discussions of procedures associated with these and other training and testing events are presented in Chapter 5 (Mitigation).

Simonis et al. (2020) relied on substantially incomplete or inaccurate assumptions about U.S. Navy sonar use around the Mariana Islands (i.e., publicly available press releases and news reports about named Navy activities, which may or may not have involved sonar, rather than actual records of sonar use) to claim a correlation between sonar and beaked whale strandings in the Mariana Islands (outside of the NWTT Study Area). Simonis et al. (2020) found that there was a 1 percent probability of the strandings and sonar co-occurring randomly. In response to the preliminary analysis of Simonis et al., the Navy provided additional information to the researchers indicating that the assumptions about sonar use in their analysis were incorrect or incomplete; therefore, their published findings were not valid. In discussions with NMFS following Simonis et al.'s findings, including NMFS researchers who participated in Simonis et al.'s study, the Navy agreed to examine the classified sonar record around the Mariana Islands for correlation with beaked whale strandings. The Center for Naval Analysis conducted a statistical study of correlation of beaked whale strandings around the Mariana Islands with the use of U.S. Navy sonar, finding that no statistically significant correlation exists (Center for Naval Analysis, 2020). The Center for Naval Analysis study used the complete classified record of all U.S. Navy sonar used between 2007 and 2019, including major training events, joint exercises, and unit level training/testing. Sonar sources in this record conservatively included both hull-mounted and non-hull-mounted sources, rather than solely hull-mounted sources (which have been previously associated with a limited number of beaked whale strandings outside of this Study Area). The analysis also included the complete beaked whale stranding record for the Mariana Islands through 2019. Following the methods in Simonis et al. (2020), the Center for Naval Analysis conducted a Poisson distribution analysis and found no statistically significant correlation between sonar use and beaked whale strandings when considering the complete sonar use record. The unclassified summary of the Center for Naval Analysis's study was provided to NMFS and their scientists. The Navy Is supporting continued efforts to gain a better understanding of beaked whale occurrence and potential effects from Navy activities in the Mariana Islands.

Multiple hypotheses regarding the relationship between non-impulsive sound exposure and stranding have been proposed (see Bernaldo de Quirós et al., 2019). These range from direct impact of the sound on the physiology of the marine mammal, to behavioral reactions contributing to altered physiology (e.g., "gas and fat embolic syndrome") (Fernandez et al., 2005; Jepson et al., 2003; Jepson et al., 2005), to behaviors directly contributing to the stranding (e.g., beaching of fleeing animals). Unfortunately, without direct observation of not only the event but also the underlying process, and given the potential for artefactual evidence (e.g., chronic condition, previous injury) to complicate conclusions from the post-mortem analyses of stranded animals (Cox et al., 2006), it has not been possible to determine with certainty the exact mechanism underlying these strandings. Based on examination of the above sonar-associated strandings, Bernaldo de Quirós et al. (2019) list diagnostic features, the presence of all of which suggest gas and fat embolic syndrome for beaked whales stranded in association with sonar exposure. Bernaldo de Quirós et al. (2019) observed that, to date, strandings which have a confirmed association with naval exercise have exhibited all seven of the following diagnostic features:

1. Individual or multiple animals stranded within hours or a few days of an exercise in good body condition;
2. Food remnants in the first gastric compartment ranging from undigested food to squid beaks;
3. Abundant gas bubbles widely distributed in veins (subcutaneous, mesenteric, portal, coronary, subarachnoid veins, etc.) composed primarily of nitrogen in fresh carcasses;
4. Gross subarachnoid and/or acoustic fat hemorrhages;
5. Microscopic multi-organ gas and fat emboli associated with bronchopulmonary shock;
6. Diffuse, mild to moderate, acute, monophasic myonecrosis (hyaline degeneration) with 'disintegration' of the interstitial connective tissue and related structures, including fat deposits, and their replacement by amorphous hyaline material (degraded material) in fresh and well-preserved carcasses; and
7. Multi-organ microscopic hemorrhages of varying severity in lipid-rich tissues such as the central nervous system, spinal cord, and the coronary and kidney fat when present.

Historically, stranding reporting and response efforts have been inconsistent, although they have improved considerably over the last 25 years. Although reporting forms have been standardized nationally, data collection methods, assessment methods, detail of reporting and procedures vary by region and are not yet standardized across the United States. Conditions such as weather, time, location, and decomposition state may also affect the ability to thoroughly examine a specimen (Carretta et al., 2016b; Moore et al., 2013). Because of this, the current ability to interpret long-term trends in marine mammal stranding is limited. While the investigation of stranded animals provides insight into the types of threats marine mammal populations face, investigations are only conducted on a small fraction of the total number of strandings that occur, limiting the understanding of the causes of strandings (Carretta et al., 2016a). Although many marine mammals likely strand due to natural or anthropogenic causes, the majority of reported type of occurrences in marine mammal strandings in the Pacific include fisheries interactions, entanglement, vessel strike, and predation (Carretta et al., 2019a; Carretta et al., 2019b; Carretta et al., 2017b; Helker et al., 2019; Helker et al., 2017; National Oceanic and Atmospheric Administration, 2018d, 2019a).

Between May 2 and June 2, 2003, approximately 16 strandings involving 15 harbor porpoises (*Phocoena phocoena*) and one Dall's porpoise (*Phocoenoides dalli*) had been reported to the Northwest Marine Mammal Stranding Network. Given that the USS SHOUP was known to have operated sonar in the strait on May 5, and that behavioral reactions of killer whales (*Orcinus orca*) had been supposedly linked to these sonar operations (National Marine Fisheries Service, 2005), NMFS undertook an analysis of whether sonar caused the strandings of the harbor porpoises. It was subsequently determined that those 2003 strandings and similar harbor porpoise strandings over the following years were normal given a number of factors as described in Huggins et al. (2015). In the 2015 NWTT Final EIS/OEIS, a comprehensive review of all strandings and the events involving USS SHOUP on May 5, 2003, were discussed. Additional information on this event is available in the Navy's Technical Report on Marine Mammal Strandings Associated with U.S. Navy Sonar Activities (U.S. Department of the Navy, 2017e). It is important to note that in the years since the SHOUP incident, annual numbers of stranded porpoises not only increased, but also showed similar causes of death (when determinable) to the causes of death noted in the SHOUP investigation (Huggins et al., 2015).

Stranded marine mammals are reported along the entire western coast of the United States each year. Marine mammals strand due to natural or anthropogenic causes, the majority of reported type of occurrences in marine mammal strandings in this region include fishery interactions, illness, predation, and vessel strikes (Carretta et al., 2017b; Helker et al., 2017; National Marine Fisheries Service, 2016j). It is important to note that the mass stranding of pinnipeds along the west coast considered part of a NMFS declared Unusual Morality Event are still being evaluated. The likely cause of this event is the lack of available prey near rookeries due to warming ocean temperatures (National Oceanic and Atmospheric Administration, 2018a). Additionally, the causes of a recently declared Unusual Mortality Event for gray whales along the west coast are being evaluated. These Unusual Mortality Events are discussed above in the background section for each species. Carretta et al. (2016b; 2013a) provide additional information and data on the threats from human-related activities and the potential causes of strandings for the U.S. Pacific coast marine mammal stocks.

3.4.2.1.1.7 Long-Term Consequences

Long-term consequences to a population are determined by examining changes in the population growth rate (see Section 3.0.3.7, Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities). Physical effects that could lead to a reduction in the population growth rate include mortality or injury, which could remove animals from the reproductive pool, and permanent hearing impairment or chronic masking, which could impact navigation, foraging, predator avoidance, or communication. The long-term consequences due to individual behavioral reactions and short-term or chronic instances of physiological stress are especially difficult to predict because individual experience over time can create complex contingencies, especially for long-lived animals like marine mammals. For example, a lost reproductive opportunity could be a measurable cost to the individual, or for very small populations to the population as a whole (e.g., Southern resident killer whale); however, short-term costs may be recouped during the life of an otherwise healthy individual. These factors are taken into consideration when assessing risk of long-term consequences. It is more likely that any long-term consequences to an individual would be a result of costs accumulated over a season, year, or life stage due to multiple behavioral or stress responses resulting from exposure to many sound-producing activities over significant periods.

Marine mammals exposed to high levels of human activities may leave the area, habituate to the activity, or tolerate the disturbance and remain in the area (Wartzok et al., 2003). Highly resident or localized populations may also stay in an area of disturbance because the cost of displacement may be higher than the cost of remaining (Forney et al., 2017).

Longer term displacement can lead to changes in abundance or distribution patterns of the species in the affected region (Bejder et al., 2006b; Blackwell et al., 2004; Teilmann et al., 2006). Gray whales in Baja California abandoned a historical breeding lagoon in the mid-1960s due to an increase in dredging and commercial shipping operations. However, whales did repopulate the lagoon after shipping activities had ceased for several years (Bryant et al., 1984). Mysticetes in the northeast tended to adjust to vessel traffic over a number a of years, trending towards more neutral responses to passing vessels (Watkins, 1986), indicating that some animals may habituate or otherwise learn to cope with high levels of human activity. Bejder et al. (2006a) studied responses of bottlenose dolphins to vessel approaches and found that lesser reactions in populations of dolphins regularly subjected to high levels of vessel traffic could be a sign of habituation, or it could be that the more sensitive animals in this population previously abandoned the area of higher human activity.

Moore and Barlow (2013) noted a decline in the overall beaked whale population in a broad area of the Pacific Ocean along the U.S. West Coast. Moore and Barlow (2013) provide several hypotheses for the decline of beaked whales in those waters, one of which is anthropogenic sound including the use of sonar by the U.S. Navy; however, new data has been published raising uncertainties over whether a decline in the beaked whale population occurred off the U.S. West Coast between 1996 and 2014 (Barlow, 2016). Moore and Barlow (2017) have since incorporated information from the entire 1991 to 2014 time series, which suggests an increasing abundance trend and a reversal of the declining trend along the U.S. West Coast that had been noted in their previous (2013) analysis.

In addition, studies on the Atlantic Undersea Test and Evaluation Center instrumented range in the Bahamas have shown that some Blainville's beaked whales may be resident during all or part of the year in the area. Individuals may move off the range for several days during and following a sonar event, but return within a few days (Joyce et al., 2019; McCarthy et al., 2011; Tyack et al., 2011). Photo-identification studies in the Southern California Range Complex have identified approximately 100 individual Cuvier's beaked whale individuals, with 40 percent having been seen in one or more prior years and re-sightings up to seven years apart (Falcone & Schorr, 2014; Falcone et al., 2009). These results indicate long-term residency by individuals in an intensively used Navy training and testing area, which may suggest a lack of long-term consequences as a result of exposure to Navy training and testing activities, but could also be indicative of high-value resources that exceed the cost of remaining in the area. Long-term residency does not mean there has been no impact to population growth rates and there are no data existing on the reproductive rates of populations inhabiting the Navy range area around San Clemente Island as opposed to beaked whales from other areas. In that regard however, recent results from photo-identifications are beginning to provide critically needed calving and weaning rate data for resident animals on the Navy's Southern California range. Three adult females that had been sighted with calves in previous years were again sighted in 2016, one of these was associated with her second calf, and a fourth female that was first identified in 2015 without a calf, was sighted in 2016 with a calf (Schorr et al., 2017). Resident females documented with and without calves from year to year will provide the data for this population that can be applied to future research questions.

Research involving three tagged Cuvier's beaked whales in the Southern California Range Complex reported on by Falcone and Schorr (2012, 2014) has documented movements in excess of hundreds of kilometers by some of those animals. Schorr et al. (2014) reported the results for an additional eight tagged Cuvier's beaked whales in the same area. Five of these eight whales made journeys of approximately 250 km from their tag deployment location, and one of these five made an extra-regional excursion over 450 km south to Mexico and back again. Given that some beaked whales may routinely move hundreds of kilometers as part of their normal pattern (Schorr et al., 2014), temporarily leaving an area to avoid sonar or other anthropogenic activity may have little cost.

Another approach to investigating long-term consequences of anthropogenic noise exposure has been an attempt to link short-term effects to individuals from anthropogenic stressors with long-term consequences to populations using population models. Population models are well known from many fields in biology including fisheries and wildlife management. These models accept inputs for the population size and changes in vital rates of the population, such as the mean values for survival age, lifetime reproductive success, and recruitment of new individuals into the population. Unfortunately, for acoustic and explosive impacts on marine mammal populations, many of the inputs required by population models are not known. Nowacek et al. (2016) reviewed new technologies, including passive acoustic monitoring, tagging, and the use of unmanned aerial vehicles that can improve scientists' abilities to study these model inputs and link behavioral changes to individual life functions and ultimately population-level effects. The linkage between immediate behavioral or physiological effects to an individual due to a stressor such as sound, the subsequent effects on that individual's vital rates (growth, survival, and reproduction), and in turn the consequences for the population have been reviewed in National Research Council (2005).

The Population Consequences of Acoustic Disturbance model (National Research Council 2005) proposes a conceptual model for determining how changes in the vital rates of individuals (i.e., a biologically significant consequence to the individual) translates into biologically significant consequences to the population. In 2009, the U.S. Office of Naval Research set up a working group to transform the Population Consequences of Acoustic Disturbance framework into a mathematical model and include other stressors potentially causing disturbance in addition to noise. The model, now called Population Consequences of Disturbance, has been used for case studies involving bottlenose dolphins, North Atlantic right whales, beaked whales, southern elephant seals, California sea lions, blue whales, humpback whales, and harbor porpoise (Costa et al., 2016a; Costa et al., 2016b; Harwood & King, 2014; Hatch et al., 2012; King et al., 2015; McHuron et al., 2018; New et al., 2014; New et al., 2013a; Pirotta et al., 2018a; Pirotta et al., 2018b). Currently, the Population Consequences of Disturbance model provides a theoretical framework and identifies types of data that would be needed to assess population-level impacts using this process. The process is complicated and provides a foundation for the type of data that is needed, which is currently lacking for many marine mammal species (Booth et al., 2020). Relevant data needed for improving these analytical approaches for population-level consequences resulting from disturbances will continue to be collected during projects funded by the Navy's marine species monitoring program.

Costa et al. (2016a) emphasized taking into account the size of an animal's home range, whether populations are resident and non-migratory or if they migrate over long areas and share their feeding or breeding areas with other populations. These factors, coupled with the extent, location, and duration of a disturbance can lead to markedly different impact results. For example, Costa et al. (2016a) modeled seismic surveys with different radii of impacts on the foraging grounds of Bering Sea humpback whales, West Antarctic Peninsula humpback whales, and California Current blue whales, and used data from tagged whales to determine foraging locations and effort on those grounds. They found that for the blue whales and the West Antarctic humpback whales, less than 19 percent and 16 percent (respectively) of each population would be exposed, and less than 19 percent and 6 percent (respectively) of foraging behavior would be disturbed. This was likely due to the fact that these populations forage for krill over large areas. In contrast, the Bering Sea population of humpback whales had over 90 percent of the population exposed when the disturbance zones extended beyond 50 km, but 100 percent of their foraging time would occur during an exposure when the zone was 25 km or more. These animals forage for fish over a much smaller area, thereby having a limited range for foraging that can be disturbed. Similarly, Costa et al. (2016b) placed disturbance zones in the foraging and transit areas of northern elephant seals and California sea lions. Again, the location and radius of disturbance impacted how many animals were exposed and for how long, with California sea lions disturbed for a longer period than elephant seals, which extend over a broader foraging and transit area. However, even the animals exposed for the longest periods had negligible modeled impacts on their reproduction and pup survival rates. Energetic costs were estimated for western gray whales that migrated to possible wintering grounds near China or to the Baja California wintering grounds of eastern gray whales versus the energetic costs of the shorter migration of eastern gray whales (Villegas-Amtmann et al., 2017). Researchers found that when the time spent on the breeding grounds was held constant for both populations, the energetic requirements for the western gray whales were estimated to be 11 and 15 percent greater during the migration to Baja California and China, respectively, than for the migration of eastern gray whales, and therefore this population would be more sensitive to energy lost through disturbance.

Pirotta et al. (2018b) modeled one reproductive cycle of a female North Pacific blue whale, starting with leaving the breeding grounds off Baja California to begin migrating north to feeding grounds off California, and ending with her returning to the breeding grounds, giving birth, and lactating. They modeled this scenario with no disturbance and found 95 percent calf recruitment; under a “normal” environmental perturbation (El Niño-Southern Oscillation) there was a very small reduction in recruitment, and, under an “unprecedented” environmental change, recruitment was reduced to 69 percent. An intense, localized anthropogenic disturbance was modeled (although the duration of the event was not provided); if the animals were not allowed to leave the area, they did not forage and recruitment dropped to 63 percent. However, if animals could leave the area of the disturbance then there was almost no change to the recruitment rate. A weak but broader spatial disturbance, where foraging was reduced by 50 percent, caused only a small decrease in calf recruitment to 94 percent. Similarly, Hin et al. (2019) looked at the impacts of disturbance on long-finned pilot whales and found that the timing of the disturbance with seasonally-available resources is important. If a disturbance occurred during periods of low resource availability, the population-level consequences were greater than if the disturbance occurred during periods when resource levels were high.

Using the Population Consequences of Disturbance framework, modeling of the long-term consequences of exposure has been conducted for a variety of marine mammal species and stressors. Even when high and frequent exposure levels are included, few long-term consequences have been predicted. For example, De Silva et al. (2014) conducted a population viability analysis on the long-term impacts of pile driving and construction noise on harbor porpoises and bottlenose dolphins. Despite including the extreme and unlikely assumptions that 25 percent of animals that received PTS would die, and that behavioral displacement from an area would lead to breeding failure, the model only found short-term impacts on the population size and no long-term effects on population viability. Similarly, King et al. (2015) developed a Population Consequences of Disturbance framework using expert elicitation data on impacts from wind farms on harbor porpoises, and even under the worst case scenarios predicted less than a 0.5 percent decline in harbor porpoise populations. Nabe-Nelson et al. (2014) also modeled the impact of noise from wind farms on harbor porpoises and predicted that even when assuming a 10 percent reduction in population size if prey is impacted up to two days, the presence of ships and wind turbines did not deplete the population. In contrast, Heinis and De Jong (2015) used the Population Consequences of Disturbance framework to estimate impacts from both pile driving and seismic exploration on harbor porpoises and found a 23 percent decrease in population size over six years, with an increased risk for further reduction with additional disturbance days. These seemingly contradictory results demonstrate that refinements to models need to be investigated to improve consistency and interpretation of model results.

Recent studies have investigated the potential consequences of fasting for harbor porpoises because their high metabolic rate may leave them especially vulnerable to disturbances that prevent them from feeding. Kastelein et al. (2019c) used an opportunistic experimental approach whereby four stranded wild harbor porpoises were able to consume 85–100 percent of their daily food mass intake in a short time period with no physical problems, suggesting they can compensate for periods of missed feeding if food is available. Similarly, using a modelled approach, Booth (2019) found that harbor porpoises are capable of recovering from lost foraging opportunities, largely because of their varied diet, high foraging rates, and high prey capture success. Booth (2020) later modeled the foraging behavior and known prey species and sizes, and found that, due to their generalist feeding behavior in most scenarios, the porpoises obtained more than 100 percent of their energetic needs through typical foraging behavior, and further confirmed that porpoises would largely be robust to short-term disturbances to foraging.

The Population Consequences of Disturbance model developed by New et al. (2013b) predicted that beaked whales require energy dense prey and high quality habitat, and that non-lethal disturbances that displace whales from that habitat could lead to long-term impacts on fecundity and survival; however, the authors were forced to use many conservative assumptions within their model since many parameters are unknown for beaked whales. As discussed above in Schorr et al. (2014), beaked whales have been tracked roaming over distances of 250 km or more, indicating that temporary displacement from a small area may not preclude finding energy dense prey or high quality habitat. Farmer et al. (2018) developed a bioenergetics framework to examine the impact of foraging disruption on body reserves of individual sperm whales. The authors examined rates of daily foraging disruption to predict the number of days to terminal starvation for various life stages, assuming exposure to seismic surveys. Mothers with calves were found to be most vulnerable to disruptions. In addition, Derous et al. (2020) proposed that blubber thickness, which has been used to measure cetacean energy stores and health, is not an appropriate metric to use, because marine mammals may not use their fat stores in a similar manner to terrestrial mammals. These results may be useful in the development of future Population Consequences of Multiple Stressors and Population Consequences of Disturbance models since they should seek to qualify cetacean health in a more ecologically relevant manner.

Another Population Consequences of Disturbance model developed in New et al. (2014) predicted elephant seal populations to be relatively robust even with a greater than 50 percent reduction in foraging trips (only a 0.4 percent population decline in the following year). McHuron et al. (2018) modeled the introduction of a generalized disturbance at different times throughout the breeding cycle of California sea lions, with the behavior response being an increase in the duration of a foraging trip by the female. Very short duration disturbances or responses led to little change, particularly if the disturbance was a single event, and changes in the timing of the event in the year had little effect. However, with even relatively short disturbances or mild responses, when a disturbance was modeled as recurring there were resulting reductions in population size and pup recruitment. Often, the effects weren't noticeable for several years, as the impacts on pup recruitment did not affect the population until those pups were mature.

Population Consequences of Disturbance models can also be used to assess the impacts of multiple stressors. For example, Farmer et al. (2018) modeled the combined impacts of an oil spill and acoustic disturbance due to seismic airgun surveys. They found that the oil spill led to declines in the population over 10 years, and some models that included behavioral response to airguns found further declines. However, the amount of additional population decline due to acoustic disturbance depended on the way the dose-response of the noise levels were modeled, with a single step-function leading to higher impacts than a function with multiple steps and frequency weighting. In addition, the amount of impact from both disturbances was mediated when the metric in the model that described animal resilience was changed to increase resilience to disturbance (e.g., able to make up reserves through increased foraging).

It should be noted that, in all of these models, assumptions were made and many input variables were unknown and so were estimated using available data. It is still not possible to utilize individual short-term behavioral responses to estimate long-term or population-level effects.

The best assessment of long-term consequences from Navy training and testing activities will be to monitor the populations over time within the Study Area. A U.S. workshop on Marine Mammals and Sound (Fitch et al., 2011) indicated a critical need for baseline biological data on marine mammal abundance, distribution, habitat, and behavior over sufficient time and space to evaluate impacts from human-generated activities on long-term population survival. The Navy developed and implemented comprehensive monitoring plans since 2009 for protected marine mammals occurring on Navy ranges with the goal of assessing the impacts of training and testing activities on marine species and the effectiveness of the Navy's mitigation measures. The results of this long-term monitoring are now being compiled and analyzed for trends in occurrence or abundance over time (e.g., Martin et al., 2017); preliminary results of this analysis at Pacific Missile Range Facility off Kauai, Hawaii indicate no changes in detection rates for several species over the past decade, demonstrating that Navy activities may not be having long-term population-level impacts. This type of analysis can be expanded to the other Navy ranges, such as in the Pacific Northwest. Continued analysis of this 15-year dataset and additional monitoring efforts over time are necessary to fully understand the long-term consequences of exposure to military readiness activities.

3.4.2.1.2 Impacts from Sonar and Other Transducers

Sonar and other transducers proposed for use could be used throughout the Study Area. Sonar and other transducers emit sound waves into the water to detect objects, safely navigate, and communicate. General categories of these systems are described in Section 3.0.3.1 (Acoustic Stressors).

Sonar-induced acoustic resonance and bubble formation phenomena are very unlikely to occur under realistic conditions, as discussed in Section 3.4.2.1.1.1 (Injury). Non-auditory injury (i.e., other than PTS) and mortality from sonar and other transducers is so unlikely as to be discountable under normal conditions and is therefore not considered further in this analysis.

The most probable impacts from exposure to sonar and other transducers are PTS, TTS, behavioral reactions, masking, and physiological stress (Sections 3.4.2.1.1.2, Hearing Loss; 3.4.2.1.1.3, Physiological Stress; 3.4.2.1.1.4, Masking; and 3.4.2.1.1.5, Behavioral Reactions).

3.4.2.1.2.1 Methods for Analyzing Impacts from Sonars and Other Transducers

The Navy performed a quantitative analysis to estimate the number of times that marine mammals could be affected by sonars and other transducers used during Navy training and testing activities. The Navy's quantitative analysis to determine impacts on marine mammals uses the Navy Acoustic Effects Model to produce initial estimates of the number of times that animals may experience these effects; these estimates are further refined by considering animal avoidance of sound-producing activities and implementation of procedural mitigation measures. The steps of this quantitative analysis are described in Section 3.0.1.2 (Navy's Quantitative Analysis to Determine Impacts to Sea Turtles and Marine Mammals), which takes into account:

- criteria and thresholds used to predict impacts from sonar and other transducers (see below);
- the density (U.S. Department of the Navy, 2020) and spatial distribution (Watwood et al., 2018) of marine mammals; and
- the influence of environmental parameters (e.g., temperature, depth, salinity) on sound propagation when estimating the received sound level on the animals.

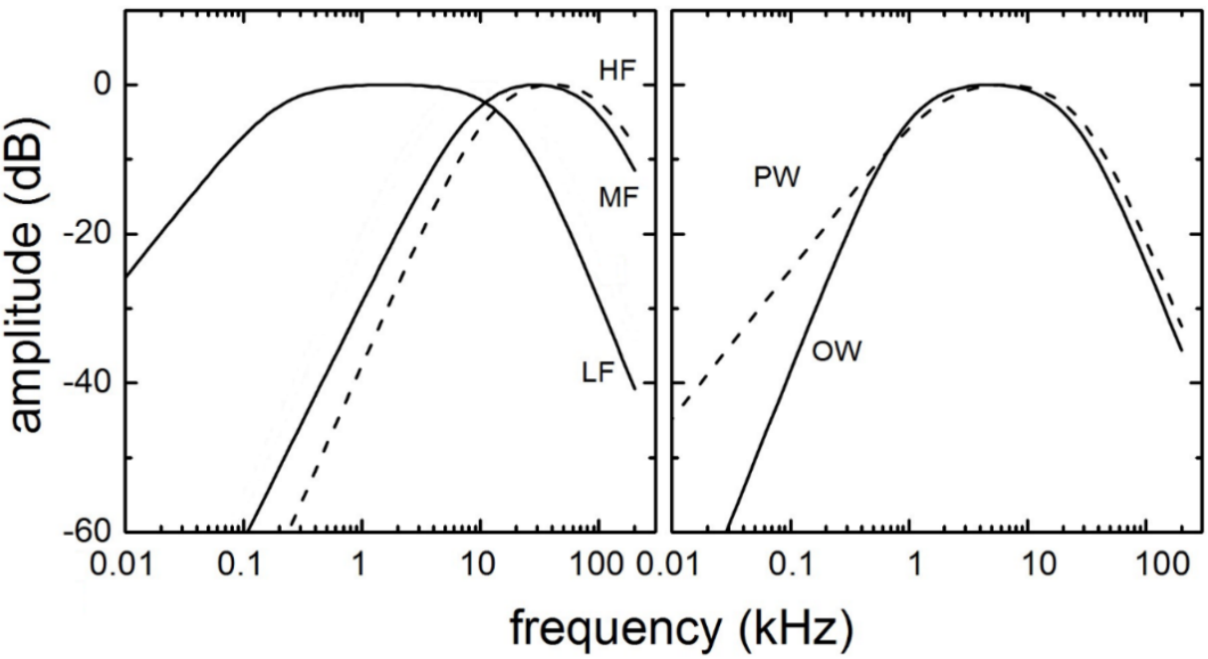
A detailed explanation of this analysis is provided in the technical report titled *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Department of the Navy, 2018c).

Criteria and Thresholds Used to Estimate Impacts from Sonar and Other Transducers

See the technical report titled *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017a) for detailed information on how the criteria and thresholds were derived. The marine mammal criteria and thresholds developed for that technical report were relied on by National Marine Fisheries Service in establishing guidance for assessing the effects of sound on marine mammal hearing (National Marine Fisheries Service, 2016k) and were re-affirmed in the 2018 revision (National Marine Fisheries Service, 2018a). In addition, these auditory impact criteria were recently published by Southall et al. (2019a).

Auditory Weighting Functions

Animals are not equally sensitive to noise at all frequencies. To capture the frequency-dependent nature of the effects of noise, auditory weighting functions are used (Figure 3.4-7). Auditory weighting functions are mathematical functions that adjust received sound levels to emphasize ranges of best hearing and de-emphasize ranges with less or no auditory sensitivity. They are based on a generic band pass filter and incorporates species-specific hearing abilities to calculate a weighted received sound level in units SPL or SEL. Due to the band pass nature of auditory weighting functions, they resemble an inverted “U” shape with amplitude plotted as a function of frequency. The flatter portion of the plotted function, where the amplitude is closest to zero, is the emphasized frequency range (i.e., the pass-band), while the frequencies below and above this range (where amplitude declines) are de-emphasized.

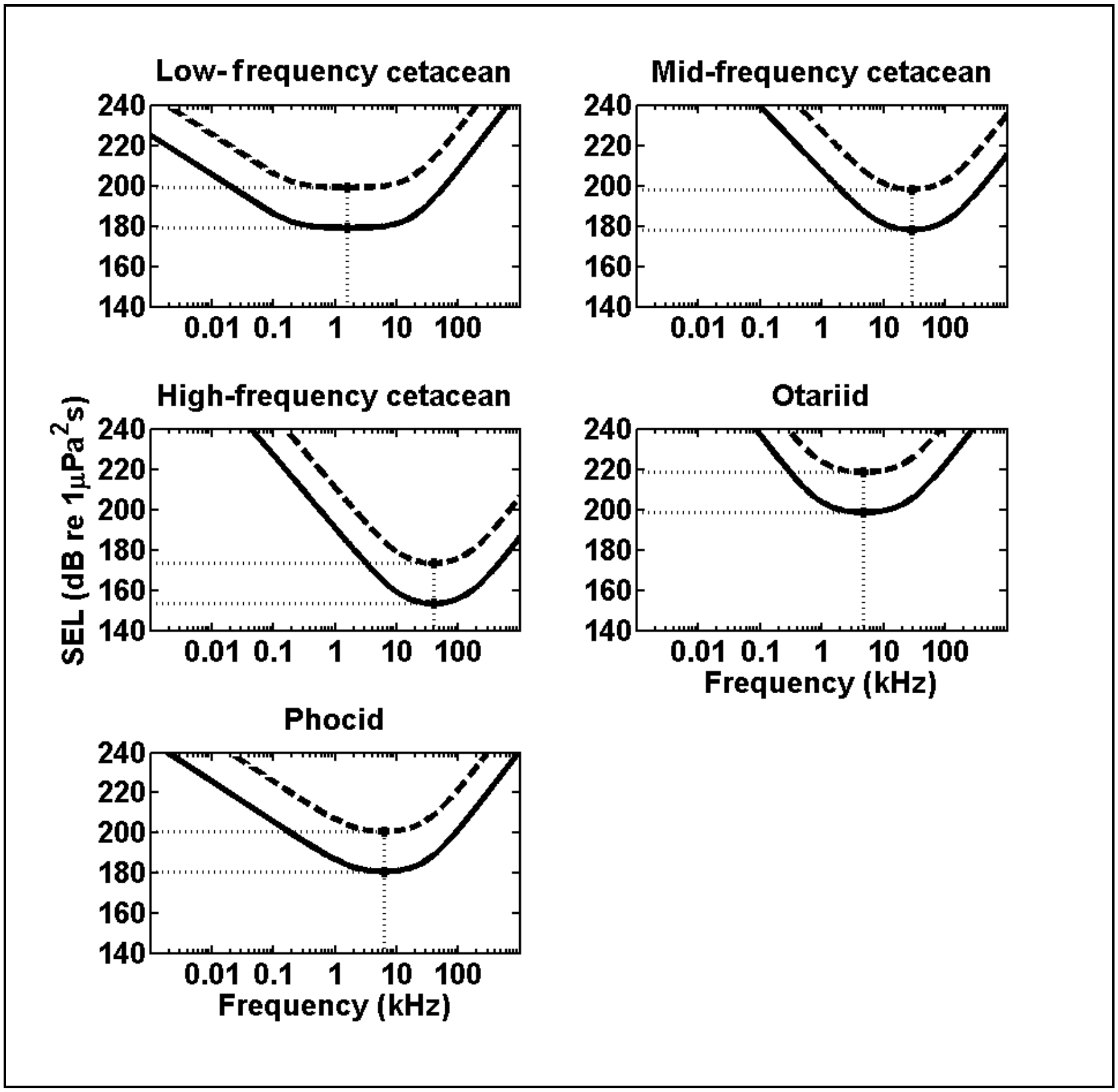


Source: For parameters used to generate the functions and more information on weighting function derivation, see the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* technical report U.S. Department of the Navy (2017b)
Notes: HF = high-frequency cetacean, LF = low-frequency cetacean, MF = mid-frequency cetacean, PW = phocid (in-water), and OW = otariid and other non-phocid marine carnivores (in-water).

Figure 3.4-7: Navy Auditory Weighting Functions for All Species Groups

Hearing Loss from Sonar and Other Transducers

Defining the TTS and PTS exposure functions (Figure 3.4-8) requires identifying the weighted exposures necessary for TTS and PTS onset from sounds produced by sonar and other transducers. The criteria used to define TSs from non-impulsive sources (e.g., sonar) determines TTS onset as the SEL necessary to induce 6 dB of TS. An SEL 20 dB above the onset of TTS is used in all hearing groups of marine mammals underwater to define the PTS threshold (Southall et al., 2007).



Notes: The solid curve is the exposure function for TTS onset and the large dashed curve is the exposure function for PTS onset. Small dashed lines and asterisks indicate the SEL threshold for TTS and PTS onset in the frequency range of best hearing. The Otariid hearing group includes other non-phocid marine carnivores.

Figure 3.4-8: TTS and PTS Exposure Functions for Sonar and Other Transducers

Behavioral Responses from Sonar and Other Transducers

Behavioral response criteria are used to estimate the number of animals that may exhibit a behavioral response to sonar and other transducers. See the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* technical report for detailed information on how the Behavioral Response Functions were derived (U.S. Department of the Navy, 2017b). Developing the new behavioral criteria involved multiple steps. All peer-reviewed published behavioral response studies conducted both in the field and on captive animals were examined in order to understand the breadth of behavioral responses of marine mammals to sonar and other transducers.

The data from the behavioral studies were analyzed by looking for significant responses, or lack thereof, for each experimental session. The terms "significant response" or "significant behavioral response" are used in describing behavioral observations from field or captive animal research that may rise to the level of "harassment" for military readiness activities. Under the MMPA, for military readiness activities, such as Navy training and testing, behavioral "harassment" is: "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*" (16 U.S.C. section 1362(3)(18)(B)). Under the ESA, the National Marine Fisheries Service has issued interim guidance on the term "harass," defining it as an action that "creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering."

The likelihood of injury due to disruption of normal behaviors would depend on many factors, such as the duration of the response, from what the animal is being diverted, and life history of the animal. Due to the nature of behavioral response research to date, it is not currently possible to ascertain the types of observed reactions that would lead to an abandonment or significant alteration of a natural behavior pattern. Therefore, the Navy developed a methodology to estimate the possible significance of behavioral reactions and impacts on natural behavior patterns.

Behavioral response severity is described herein as "low," "moderate," or "high." These are derived from the Southall et al. (2007) severity scale. Low severity responses are those behavioral responses that fall within an animal's range of typical (baseline) behaviors and are unlikely to disrupt an individual to a point where natural behavior patterns are significantly altered or abandoned. Low severity responses include an orientation or startle response, change in respiration, change in heart rate, and change in group spacing or synchrony.

Moderate severity responses could become significant if sustained over a longer duration. What constitutes a long-duration response is different for each situation and species, although it is likely dependent upon the magnitude of the response and species characteristics such as age, body size, feeding strategy, and behavioral state at the time of the exposure. In general, a response could be considered "long-duration" if it lasted for tens of minutes to a few hours, or enough time to significantly disrupt an animal's daily routine.

Moderate severity responses included:

- alter migration path
- alter locomotion (speed, heading)
- alter dive profiles
- stop/alter nursing
- stop/alter breeding
- stop/alter feeding/foraging
- stop/alter sheltering/resting
- stop/alter vocal behavior if tied to foraging or social cohesion
- avoid area near sound source

For the derivation of behavioral criteria, a significant duration was defined as a response that lasted for the duration of exposure or longer, regardless of how long the exposure session may have been. This assumption was made because it was not possible to tell if the behavioral responses would have continued if the exposure had continued. The costs associated with these observed behavioral reactions were not measured so it is not possible to judge whether reactions would have risen to the level of significance as defined above, although it was conservatively assumed the case. High severity responses include those responses with immediate consequences (e.g., stranding, mother-calf separation), and were always considered significant behavioral reactions regardless of duration.

Marine mammal species were placed into behavioral criteria groups based on their known or suspected behavioral sensitivities to sound (Figure 3.4-9 through Figure 3.4-12). In most cases, these divisions are driven by taxonomic classifications (e.g., mysticetes, pinnipeds). The Odontocete group combines most of the mid- and high-frequency cetaceans, without the beaked whales or harbor porpoises, while the Pinniped group combines the otariids and phocids. These groups are combined as there is not enough data to separate them for behavioral responses.

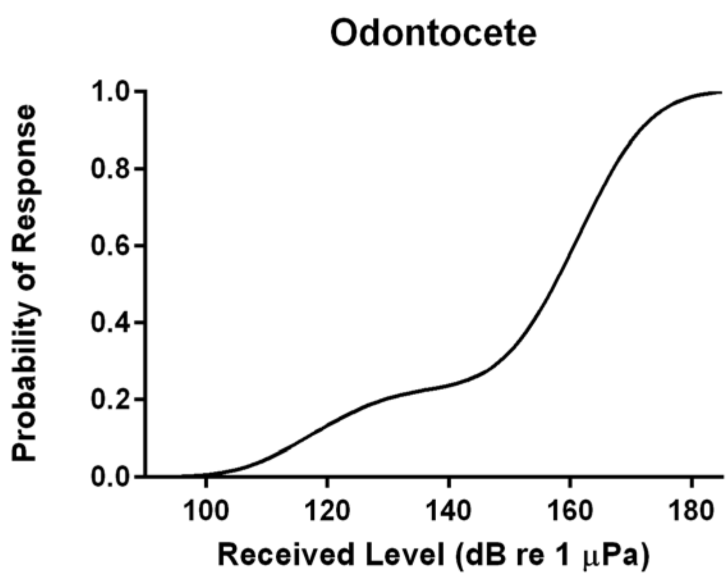


Figure 3.4-9: Behavioral Response Function for Odontocetes

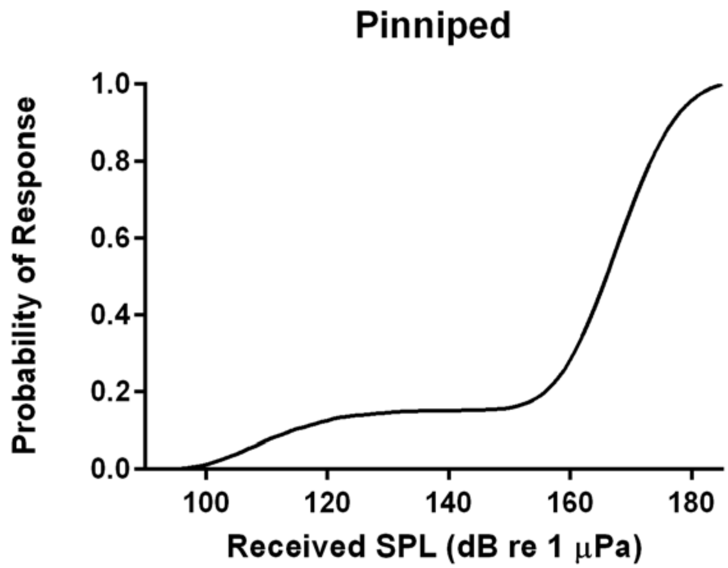


Figure 3.4-10: Behavioral Response Function for Pinnipeds

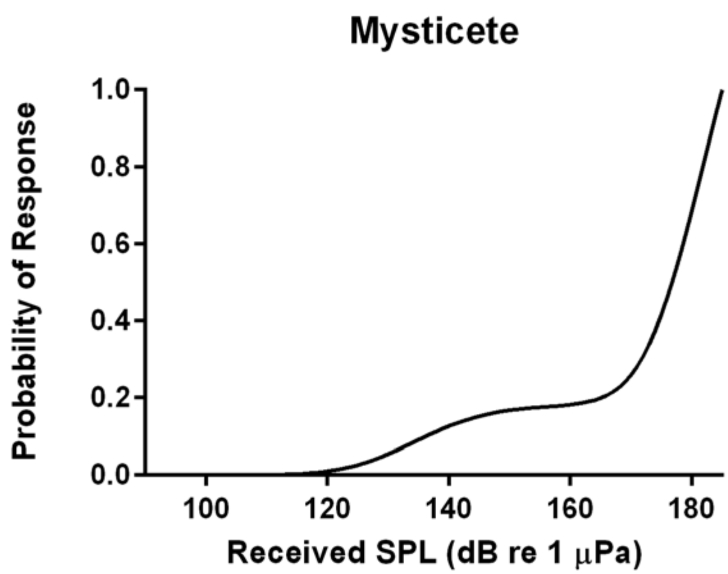


Figure 3.4-11: Behavioral Response Function for Mysticetes

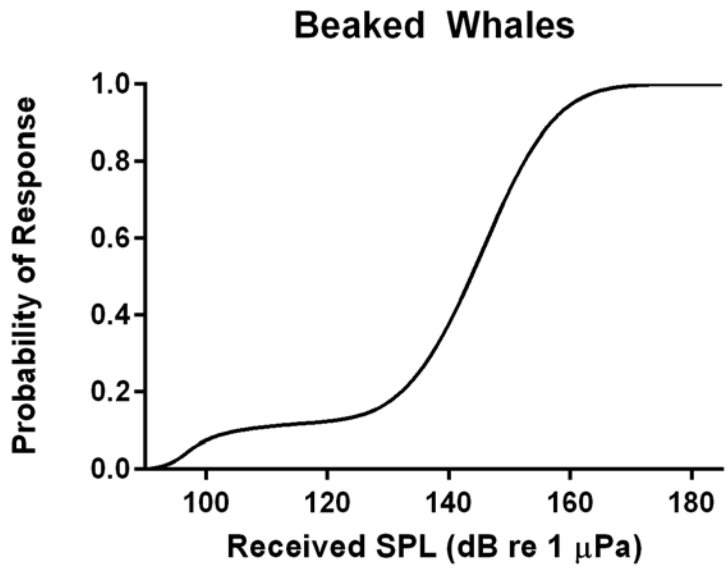


Figure 3.4-12: Behavioral Response Function for Beaked Whales

The information currently available regarding harbor porpoises suggests a very low threshold level of response for both captive and wild animals. Threshold levels at which both captive (Kastelein et al., 2000; Kastelein et al., 2005b) and wild harbor porpoises (Johnston, 2002) responded to sound (e.g., acoustic harassment devices, acoustic deterrent devices, or other non-impulsive sound sources) are very low, approximately 120 dB re 1 µPa. Therefore, a SPL of 120 dB re 1 µPa is used in this analysis as a threshold for predicting behavioral responses in harbor porpoises.

Although there is no research on the effects of sonar on sea otters, based on their low reactivity to other acoustic and anthropogenic stressors, sea otters exposed to sonar received levels below the threshold for TTS are assumed to be unlikely to exhibit behavioral responses that would be considered "harassment" under the MMPA for military readiness activities, if behavioral reactions to distant sounds occur at all.

The behavioral response functions only consider one aspect of an acoustic exposure, the received level. While the behavioral response functions applied in this analysis are an improvement from historical behavioral step functions (Tyack & Thomas, 2019), marine mammal behavioral response research suggests that the context of an exposure also affects a potential response (Ellison et al, 2011; also Section 3.4.2.1.1.5, Behavioral Reactions). The distance between the animal and the sound source is a strong factor in determining that animal's potential reaction (e.g., DeRuiter et al., 2013b). For all taxa, therefore, distances beyond which significant behavioral responses to sonar and other transducers are unlikely to occur, denoted as "cutoff distances," were defined based on existing data (Table 3.4-3).These cutoff distances include even the most distant detected responses to date (e.g., 28 km in northern bottlenose whales (Wensveen et al., 2019)). For training and testing activities that contain multiple platforms or tactical sonar sources that exceed 215 dB re 1 µPa at 1 m, this cutoff distance is substantially increased (i.e., doubled) from values derived from the literature. The use of multiple platforms and intense sound sources are factors that probably increase responsiveness in marine mammals overall. There are currently few behavioral observations under these circumstances; therefore, the Navy will conservatively predict significant behavioral responses at farther ranges for these more intense activities.

Table 3.4-3: Cutoff Distances for Moderate Source Level, Single Platform Training and Testing Events and for All Other Events with Multiple Platforms or Sonar with Source Levels at or Exceeding 215 dB re 1 µPa @ 1 m

Criteria Group	*Moderate SL/Single Platform Cutoff Distance*	*High SL/Multi-Platform Cutoff Distance*
Odontocetes	10 km	20 km
Pinnipeds and Mustelids	5 km	10 km
Mysticetes	10 km	20 km
Beaked Whales	25 km	50 km
Harbor Porpoise	20 km	40 km

Notes: dB re 1 µPa @ 1 m= decibels referenced to 1 micropascal at 1 meter, km= kilometer, SL= source level

Assessing the Severity of Behavioral Responses from Sonar under Military Readiness

As discussed above, the terms "significant response" or "significant behavioral response" are used in describing behavioral reactions that may lead to an abandonment or significant alteration of a natural behavior pattern. Due to the limited amount of behavioral response research to date and relatively short durations of observation, it is not possible to ascertain the true significance of the majority of the observed reactions. When deriving the behavioral criteria, it was assumed that most reactions that lasted for the duration of the sound exposure or longer were significant, even though many of the exposures lasted for 30 minutes or less. Furthermore, the experimental designs used during many of the behavioral response studies were unlike Navy activities in many important ways. These differences include tagging subject animals, following subjects for sometimes hours before the exposure, vectoring towards the subjects after animals began to avoid the sound source, and making multiple close passes on focal groups. This makes the estimated behavioral impacts from Navy activities using the criteria derived from these experiments difficult to interpret. While the state of science does not currently support definitively distinguishing between significant and insignificant behavioral reactions, as described in the technical report titled *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017b), Navy's analysis incorporates conservative assumptions to account for this uncertainty and therefore likely overestimates the potential impacts.

The estimated behavioral reactions from the Navy's quantitative analysis are grouped into several categories based on the most powerful sonar source, the number of platforms, the duration, and geographic extent of each Navy activity attributed to the predicted impact.

Low severity responses are within an animal's range of typical (baseline) behaviors and are unlikely to disrupt an individual to a point where natural behavior patterns are significantly altered or abandoned. Although the derivation of the Navy's behavioral criteria did not count low severity responses as significant behavioral responses, in practice, some reactions estimated using the behavioral criteria are likely to be low severity (Figure 3.4-13).

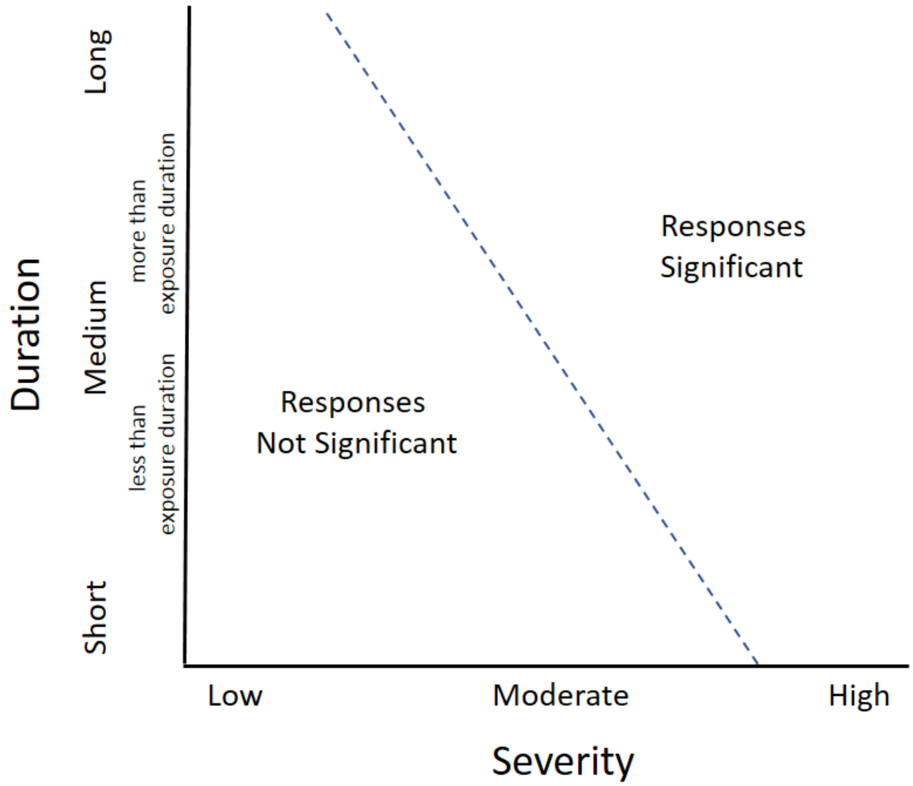


Figure 3.4-13: Relative Likelihood of a Response Being Significant Based on the Duration and Severity of Behavioral Reactions

High severity responses are those with a higher potential for direct consequences to growth, survivability, or reproduction. Examples include prolonged separation of females and dependent offspring, panic, flight, stampede, or stranding. High severity reactions would always be considered significant; however, these types of reactions are probably rare under most conditions and may still not lead to direct consequences on survivability. For example, a separation of a killer whale mother-calf pair was observed once during a behavioral response study to an active sonar source (Miller et al., 2014), but the animals were rejoined as soon as the ship had passed. Therefore, although this was a severe response, it did not lead to a negative outcome. Five beaked whale strandings have also occurred associated with U.S. Navy active sonar use as discussed above (see Section 3.4.2.1.1.6, Stranding), but the confluence of factors that contributed to those strandings is now better understood, and the avoidance of those factors has resulted in no known marine mammal strandings associated with U.S. Navy sonar activities for over a decade. The Navy is unable to predict these high severity responses for any activities since the probability of occurrence is apparently very low, although the Navy acknowledges that severe reactions could occasionally occur. In fact, no significant behavioral responses such as panic, stranding or other severe reactions have been observed during monitoring of actual training or testing activities.

Many of the responses estimated using the Navy's quantitative analysis are most likely to be moderate severity. Moderate severity responses would be considered significant if they were sustained for a duration long enough that it caused an animal to be outside of normal daily variations in feeding, reproduction, resting, migration/movement, or social cohesion. As mentioned previously, the behavioral response functions used within the Navy's quantitative analysis were primarily derived from experiments using short-duration sound exposures lasting, in many cases, for less than 30 minutes. If animals exhibited moderate severity reactions for the duration of the exposure or longer, then it was conservatively assumed that the animal experienced a significant behavioral reaction. However, the experiments did not include measurements of costs to animals beyond the immediately observed reactions, and no direct correlations exist between an observed behavioral response and a cost that may result in long-term consequences. Within the Navy's quantitative analysis, many behavioral reactions are estimated from exposure to sonar that may exceed an animal's behavioral threshold for only a single ping to several minutes. While the state of science does not currently support definitively distinguishing between significant and insignificant behavioral reactions, as described in the technical report titled *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017b), the Navy's analysis incorporates conservative assumptions to account for this uncertainty and therefore likely overestimates the potential impacts.

Accounting for Mitigation

The Navy will implement mitigation measures to avoid or reduce potential impacts from active sonar on marine mammals, as described in Section 5.3.2.1 (Active Sonar). The benefits of mitigation are conservatively factored into the analysis for Alternative 1 and Alternative 2 of the Proposed Action for training and testing. The Navy's mitigation measures are identical for both action alternatives.

Procedural mitigation measures include a power down or shut down (i.e., power off) of applicable active sonar sources when a marine mammal is observed in a mitigation zone. The mitigation zones for active sonar activities were designed to avoid the potential for marine mammals to be exposed to levels of sound that could result in auditory injury (i.e., PTS) from active sonar to the maximum extent practicable. The mitigation zones for active sonar extend beyond the respective average ranges to auditory injury (including PTS). Therefore, the impact analysis considers the potential for procedural mitigation to reduce the risk of PTS. Two factors are considered when quantifying the effectiveness of procedural mitigation: (1) the extent to which the type of mitigation proposed for a sound-producing activity (e.g., active sonar) allows for observation of the mitigation zone prior to and during the activity; and (2) the sightability of each species that may be present in the mitigation zone, which is determined by species-specific characteristics and the viewing platform. A detailed explanation of the analysis is provided in the technical report *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Department of the Navy, 2018c).

The impact analysis does not consider the potential for mitigation to reduce TTS or behavioral effects, even though mitigation could also reduce the likelihood of these effects. In practice, mitigation also protects all unobserved (below the surface) animals in the vicinity, including other species, in addition to the observed animal. However, the analysis assumes that only animals sighted at the water surface would be protected by the applied mitigation. The analysis, therefore, does not capture the protection afforded to all marine species that may be near or within the mitigation zone.

The ability to observe the ranges to PTS was estimated for each training or testing event. The ability of Navy Lookouts to detect marine mammals within a mitigation zone is dependent on the animal's presence at the surface and the characteristics of the animal that influence its sightability (such as group size or surface active behavior). The behaviors and characteristics of some species may make them easier to detect. Certain behaviors, such as leaping and breaching, are visible from a great distance and likely increase sighting distances and detections of those species. Environmental conditions under which the training or testing activity could take place are also considered, such as sea surface conditions, weather (e.g., fog or rain), and day versus night.

The Navy will also implement mitigation measures for certain active sonar activities within mitigation areas, as described in Appendix K (Geographic Mitigation Assessment). Mitigation areas are designed to help avoid or reduce impacts during biologically important life processes within particularly important habitat areas. The benefits of mitigation areas are discussed qualitatively in terms of the context of impact avoidance or reduction.

Marine Mammal Avoidance of Sonar and other Transducers

Because a marine mammal is assumed to initiate avoidance behavior after an initial startle reaction when exposed to relatively high received levels of sound, a marine mammal could reduce its cumulative sound energy exposure over a sonar event with multiple pings (i.e., sound exposures). This would reduce risk of both PTS and TTS, although the quantitative analysis conservatively only considers the potential to reduce instances of PTS by accounting for marine mammals swimming away to avoid repeated high-level sound exposures. All reductions in PTS impacts from likely avoidance behaviors are instead considered TTS impacts.

3.4.2.1.2.2 Impact Ranges for Sonar and Other Transducers

The following section provides range to effects for sonar and other transducers to specific criteria determined using the Navy Acoustic Effects Model. Marine mammals within these ranges would be predicted to receive the associated effect. Range to effects is important information in not only predicting acoustic impacts, but also in verifying the accuracy of model results against real-world situations and assessing the level of impact that will likely be mitigated within applicable mitigation zones.

The ranges to the PTS threshold for an exposure of 30 seconds are shown in Table 3.4-4 relative to the marine mammal's functional hearing group. This period (30 seconds) was chosen based on examining the maximum amount of time a marine mammal would realistically be exposed to levels that could cause the onset of PTS based on platform (e.g., ship) speed and a nominal animal swim speed of approximately 1.5 m per second. The ranges provided in the table include the average range to PTS, as well as the range from the minimum to the maximum distance at which PTS is possible for each hearing group. Since any hull-mounted sonar, such as the SQS-53, engaged in anti-submarine warfare training would be moving at between 10 and 15 knots and nominally pinging every 50 seconds, the vessel will have traveled a minimum distance of approximately 257 m during the time between those pings (note: 10 knots is the speed used in the Navy Acoustic Effects Model). As a result, there is little overlap of PTS footprints from successive pings, indicating that in most cases, an animal predicted to receive PTS would do so from a single exposure (i.e., ping). For all other bins (besides MF1), PTS ranges are short enough that marine mammals (with a nominal swim speed of approximately 1.5 meters per second) should be able to avoid higher sound levels capable of causing onset PTS within this 30-second period.

For a SQS-53C (i.e., bin MF1) sonar transmitting for 30 seconds at 3 kHz and a source level of 235 dB re 1 μPa^2-s at 1 m, the average range to PTS for the most sensitive species (the high-frequency cetaceans) extends from the source to a range of 195 m. For all other functional hearing groups (low-frequency cetaceans, mid-frequency cetaceans, phocids, otariids and mustelids), 30-second average PTS zones are substantially shorter. A scenario could occur where an animal does not leave the vicinity of a ship or travels a course parallel to the ship, however, the close distances required make PTS exposure unlikely. For a military vessel moving at a nominal 10 knots, it is unlikely a marine mammal could maintain the speed to parallel the ship and receive adequate energy over successive pings to suffer PTS.

Table 3.4-4: Ranges to Permanent Threshold Shift for Five Representative Sonar Systems

Hearing Group	Approximate PTS (30 seconds) Ranges (meters)[1]				
	Sonar bin HF4	Sonar bin LF4	Sonar bin MF1	Sonar bin MF4	Sonar bin MF5
High-frequency cetaceans	38 (22–85)	0 (0–0)	195 (80–330)	30 (30–40)	9 (8–11)
Low-frequency cetaceans	0 (0–0)	2 (1–3)	67 (60–110)	15 (15–17)	0 (0–0)
Mid-frequency cetaceans	1 (0–3)	0 (0–0)	16 (16–19)	3 (3–3)	0 (0–0)
Otariids and Mustelids	0 (0–0)	0 (0–0)	6 (6–6)	0 (0–0)	0 (0–0)
Phocids	0 (0–0)	0 (0–0)	46 (45–75)	11 (11–12)	0 (0–0)

[1] PTS ranges extend from the sonar or other transducer sound source to the indicated distance. The average range to PTS is provided as well as the range from the estimated minimum to the maximum range to PTS in parenthesis.
Notes: HF = high-frequency, LF = low-frequency, MF = mid-frequency, PTS = permanent threshold shift

The tables below illustrate the range to TTS for 1, 30, 60, and 120 seconds from five representative sonar systems (Table 3.4-5 through Table 3.4-9). Due to the lower acoustic thresholds for TTS versus PTS, ranges to TTS are longer. Therefore, successive pings can be expected to add together, further increasing the range to TTS onset. For some hearing groups and bins, the ranges to PTS and TTS are zero because the source level is low relative to threshold shift susceptibility at the relevant hearing frequency.

Table 3.4-5: Ranges to Temporary Threshold Shift for Sonar Bin HF4 over a Representative Range of Environments Within the Study Area

Hearing Group	Approximate TTS Ranges (meters)[1]			
	Sonar Bin HF4			
	1 second	30 seconds	60 seconds	120 seconds
High-frequency cetaceans	236 (60–675)	387 (60–875)	503 (60–1,025)	637 (60–1,275)
Low-frequency cetaceans	2 (0–3)	3 (1–6)	5 (3–8)	8 (5–12)
Mid-frequency cetaceans	12 (7–20)	21 (12–40)	29 (17–60)	43 (24–90)
Otariids and Mustelids	0 (0–0)	0 (0–0)	0 (0–0)	1 (0–1)
Phocids	3 (0–5)	6 (4–10)	9 (5–15)	14 (8–25)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the Study Area. The zone in which animals are expected to suffer TTS extend from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parenthesis.
Notes: HF = high frequency, TTS = temporary threshold shift

Table 3.4-6: Ranges to Temporary Threshold Shift for Sonar Bin LF4 over a Representative Range of Environments Within the Study Area

Hearing Group	*Approximate TTS Ranges (meters)[1]*			
	Sonar Bin LF4			
	1 second	*30 seconds*	*60 seconds*	*120 seconds*
High-frequency cetaceans	0 (0–0)	0 (0–0)	0 (0–0)	1 (0–1)
Low-frequency cetaceans	22 (19–30)	32 (25–230)	41 (30–230)	61 (45–100)
Mid-frequency cetaceans	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Otariids and Mustelids	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Phocids	2 (1–3)	4 (3–4)	4 (4–5)	7 (6–9)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the Study Area. The zone in which animals are expected to suffer TTS extend from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parenthesis.

Notes: LF = low-frequency, TTS = temporary threshold shift

Table 3.4-7: Ranges to Temporary Threshold Shift for Sonar Bin MF1 over a Representative Range of Environments Within the Study Area

Hearing Group	*Approximate TTS Ranges (meters)[1]*			
	Sonar Bin MF1			
	1 second	*30 seconds*	*60 seconds*	*120 seconds*
High-frequency cetaceans	2,466 (80–6,275)	2,466 (80–6,275)	3,140 (80–10,275)	3,740 (80–13,525)
Low-frequency cetaceans	1,054 (80–2,775)	1,054 (80–2,775)	1,480 (80–4,525)	1,888 (80–5,275)
Mid-frequency cetaceans	225 (80–380)	225 (80–380)	331 (80–525)	411 (80–700)
Otariids and Mustelids	67 (60–110)	67 (60–110)	111 (80–170)	143 (80–250)
Phocids	768 (80–2,025)	768 (80–2,025)	1,145 (80–3,275)	1,388 (80–3,775)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the Study Area. The zone in which animals are expected to suffer TTS extend from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parenthesis. Ranges for 1-second and 30-second periods are identical for Bin MF1 because this system nominally pings every 50 seconds; therefore, these periods encompass only a single ping.

Notes: MF = mid-frequency, TTS = temporary threshold shift

Table 3.4-8: Ranges to Temporary Threshold Shift for Sonar Bin MF4 over a Representative Range of Environments Within the Study Area

Hearing Group	***Approximate TTS Ranges (meters)[1]***			
	Sonar Bin MF4			
	1 second	***30 seconds***	***60 seconds***	***120 seconds***
High-frequency cetaceans	279 (220–600)	647 (420–1,275)	878 (500–1,525)	1,205 (525—2,275)
Low-frequency cetaceans	87 (85–110)	176 (130–320)	265 (190–575)	477 (290–975)
Mid-frequency cetaceans	22 (22–25)	35 (35–45)	50 (45–55)	71 (70–85)
Otariids and Mustelids	8 (8–8)	15 (15–17)	19 (19–23)	25 (25–30)
Phocids	66 (65–80)	116 (110–200)	173 (150–300)	303 (240–675)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the Study Area. The zone in which animals are expected to suffer TTS extend from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parenthesis.

Notes: MF = mid-frequency, TTS = temporary threshold shift

Table 3.4-9: Ranges to Temporary Threshold Shift for Sonar Bin MF5 over a Representative Range of Environments Within the Study Area

Hearing Group	***Approximate TTS Ranges (meters)[1]***			
	Sonar Bin MF5			
	1 second	***30 seconds***	***60 seconds***	***120 seconds***
High-frequency cetaceans	115 (110–180)	115 (110–180)	174 (150–390)	292 (210–825)
Low-frequency cetaceans	11 (10–13)	11 (10–13)	17 (16–19)	24 (23–25)
Mid-frequency cetaceans	6 (0–9)	6 (0–9)	12 (11–14)	18 (17–22)
Otariids and Mustelids	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Phocids	9 (8–11)	9 (8–11)	15 (14–17)	22 (21–25)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the Study Area. The zone in which animals are expected to suffer TTS extend from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parenthesis.

Notes: MF = mid-frequency, TTS = temporary threshold shift

The range to received sound levels in 6-dB steps from five representative sonar bins and the percentage of animals that may exhibit a significant behavioral response under each behavioral response function (or step function in the case of the harbor porpoise) are shown in Table 3.4-10 through Table 3.4-14, respectively. See Section 3.4.2.1.2.1 (Methods for Analyzing Impacts from Sonars and Other Transducers) for details on the derivation and use of the behavioral response functions, thresholds, and the cutoff distances.

Table 3.4-10: Ranges to a Potentially Significant Behavioral Response for Sonar Bin HF4 over a Representative Range of Environments Within the Study Area

Received Level (dB re 1 µPa)	*Mean Range (meters) with Minimum and Maximum Values in Parentheses*	*Probability of Behavioral Response for Sonar Bin HF4*				
		Odontocete	*Mysticete*	*Pinniped & Mustelid*	*Beaked Whale*	*Harbor Porpoise*
196	4 (0–7)	100%	100%	100%	100%	100%
190	10 (0–16)	100%	98%	99%	100%	100%
184	20 (0–40)	99%	88%	98%	100%	100%
178	42 (0–85)	97%	59%	92%	100%	100%
172	87 (0–270)	91%	30%	76%	99%	100%
166	177 (0–650)	78%	20%	48%	97%	100%
160	338 (25–825)	58%	18%	27%	93%	100%
154	577 (55–1,275)	40%	17%	18%	83%	100%
148	846 (60–1,775)	29%	16%	16%	66%	100%
142	1,177 (60–2,275)	25%	13%	15%	45%	100%
136	1,508 (60–3,025)	23%	9%	15%	28%	100%
130	1,860 (60–3,525)	20%	5%	15%	18%	100%
124	2,202 (60–4,275)	17%	2%	14%	14%	100%
118	2,536 (60–4,775)	12%	1%	13%	12%	0%
112	2,850 (60–5,275)	6%	0%	9%	11%	0%
106	3,166 (60–6,025)	3%	0%	5%	11%	0%
100	3,470 (60–6,775)	1%	0%	2%	8%	0%

Notes: dB re 1 µPa = decibels referenced to 1 micropascal, HF = high-frequency

Table 3.4-11: Ranges to a Potentially Significant Behavioral Response for Sonar Bin LF4 over a Representative Range of Environments Within the Study Area

Received Level (dB re 1 µPa)	*Mean Range (meters) with Minimum and Maximum Values in Parentheses*	*Probability of Behavioral Response for Sonar Bin LF4*				
		Odontocete	*Mysticete*	*Pinniped & Mustelid*	*Beaked Whale*	*Harbor Porpoise*
196	1 (0–1)	100%	100%	100%	100%	100%
190	3 (0–3)	100%	98%	99%	100%	100%
184	6 (0–8)	99%	88%	98%	100%	100%
178	13 (0–30)	97%	59%	92%	100%	100%
172	29 (0–230)	91%	30%	76%	99%	100%
166	64 (0–100)	78%	20%	48%	97%	100%
160	148 (0–310)	58%	18%	27%	93%	100%
154	366 (230–850)	40%	17%	18%	83%	100%
148	854 (300–2,025)	29%	16%	16%	66%	100%
142	1,774 (300–5,025)	25%	13%	15%	45%	100%
136	3,168 (300–8,525)	23%	9%	15%	28%	100%
130	5,167 (300–30,525)	20%	5%	15%	18%	100%
124	7,554 (300–93,775)	17%	2%	14%	14%	100%
118	10,033 (300–100,000*)	12%	1%	13%	12%	0%
112	12,700 (300–100,000*)	6%	0%	9%	11%	0%
106	15,697 (300–100,000*)	3%	0%	5%	11%	0%
100	17,846 (300–100,000*)	1%	0%	2%	8%	0%

* Indicates maximum range to which acoustic model was run, a distance of approximately 100 km from the sound source.

Notes: Cells are shaded if the mean range value for the specified received level exceeds the distance cutoff range for a particular hearing group. Any impacts within the cutoff range for a criteria group are included in the estimated impacts. Cut-off ranges in this table are for activities with high source levels and/or multiple platforms (see Table 3.4-3 for behavioral cut-off distances). dB re 1 µPa = decibels referenced to 1 micropascal, LF = low-frequency

Table 3.4-12: Ranges to a Potentially Significant Behavioral Response for Sonar Bin MF1 over a Representative Range of Environments Within the Study Area

Received Level (dB re 1 µPa)	Mean Range (meters) with Minimum and Maximum Values in Parentheses	Probability of Behavioral Response for Sonar Bin MF1				
		Odontocete	Mysticete	Pinniped and Mustelid	Beaked Whale	Harbor Porpoise
196	112 (80–170)	100%	100%	100%	100%	100%
190	262 (80–410)	100%	98%	99%	100%	100%
184	547 (80–1,025)	99%	88%	98%	100%	100%
178	1,210 (80–3,775)	97%	59%	92%	100%	100%
172	2,508 (80–7,525)	91%	30%	76%	99%	100%
166	4,164 (80–16,025)	78%	20%	48%	97%	100%
160	6,583 (80–28,775)	58%	18%	27%	93%	100%
154	10,410 (80–47,025)	40%	17%	18%	83%	100%
148	16,507 (80–63,525)	29%	16%	16%	66%	100%
142	21,111 (80–94,025)	25%	13%	15%	45%	100%
136	26,182 (80–100,000*)	23%	9%	15%	28%	100%
130	31,842 (80–100,000*)	20%	5%	15%	18%	100%
124	34,195 (80–100,000*)	17%	2%	14%	14%	100%
118	36,557 (80–100,000*)	12%	1%	13%	12%	0%
112	38,166 (80–100,000*)	6%	0%	9%	11%	0%
106	39,571 (80–100,000*)	3%	0%	5%	11%	0%
100	41,303 (80–100,000*)	1%	0%	2%	8%	0%

* Indicates maximum range to which acoustic model was run, a distance of approximately 100 km from the sound source.

Notes: Cells are shaded if the mean range value for the specified received level exceeds the distance cutoff range for a particular hearing group. Any impacts within the cutoff range for a criteria group are included in the estimated impacts. Cut-off ranges in this table are for activities with high source levels and/or multiple platforms (see Table 3.4-3 for behavioral cut-off distances). dB re 1 µPa = decibels referenced to 1 micropascal, MF = mid-frequency

Table 3.4-13: Ranges to a Potentially Significant Behavioral Response for Sonar Bin MF4 over a Representative Range of Environments Within the Study Area

Received Level (dB re 1 µPa)	*Mean Range (meters) with Minimum and Maximum Values in Parentheses*	*Probability of Behavioral Response for Sonar Bin MF4*				
		Odontocete	*Mysticete*	*Pinniped and Mustelid*	*Beaked Whale*	*Harbor Porpoise*
196	8 (0–8)	100%	100%	100%	100%	100%
190	16 (0–20)	100%	98%	99%	100%	100%
184	34 (0–40)	99%	88%	98%	100%	100%
178	68 (0–85)	97%	59%	92%	100%	100%
172	155 (120–300)	91%	30%	76%	99%	100%
166	501 (290–975)	78%	20%	48%	97%	100%
160	1,061 (480–2,275)	58%	18%	27%	93%	100%
154	1,882 (525–4,025)	40%	17%	18%	83%	100%
148	2,885 (525–7,525)	29%	16%	16%	66%	100%
142	4,425 (525–14,275)	25%	13%	15%	45%	100%
136	9,902 (525–48,275)	23%	9%	15%	28%	100%
130	20,234 (525–56,025)	20%	5%	15%	18%	100%
124	23,684 (525–91,775)	17%	2%	14%	14%	100%
118	28,727 (525–100,000*)	12%	1%	13%	12%	0%
112	37,817 (525–100,000*)	6%	0%	9%	11%	0%
106	42,513 (525–100,000*)	3%	0%	5%	11%	0%
100	43,367 (525–100,000*)	1%	0%	2%	8%	0%

*Indicates maximum range to which acoustic model was run, a distance of approximately 100 km from the sound source.

Notes: Cells are shaded if the mean range value for the specified received level exceeds the distance cutoff range for a particular hearing group. Any impacts within the cutoff range for a criteria group are included in the estimated impacts. Cut-off ranges in this table are for activities with high source levels and/or multiple platforms (see Table 3.4-3 for behavioral cut-off distances). dB re 1 µPa = decibels referenced to 1 micropascal, MF = mid-frequency

Table 3.4-14: Ranges to a Potentially Significant Behavioral Response for Sonar Bin MF5 over a Representative Range of Environments Within the Study Area

Received Level (dB re 1 µPa)	*Mean Range (meters) with Minimum and Maximum Values in Parentheses*	*Probability of Behavioral Response for Sonar Bin MF5*				
		Odontocete	*Mysticete*	*Pinniped and Mustelid*	*Beaked Whale*	*Harbor Porpoise*
196	0 (0–0)	100%	100%	100%	100%	100%
190	1 (0–3)	100%	98%	99%	100%	100%
184	5 (0–7)	99%	88%	98%	100%	100%
178	14 (0–18)	97%	59%	92%	100%	100%
172	29 (0–35)	91%	30%	76%	99%	100%
166	58 (0–70)	78%	20%	48%	97%	100%
160	127 (0–280)	58%	18%	27%	93%	100%
154	375 (0–1,000)	40%	17%	18%	83%	100%
148	799 (490–1,775)	29%	16%	16%	66%	100%
142	1,677 (600–3,525)	25%	13%	15%	45%	100%
136	2,877 (675–7,275)	23%	9%	15%	28%	100%
130	4,512 (700–12,775)	20%	5%	15%	18%	100%
124	6,133 (700–19,275)	17%	2%	14%	14%	100%
118	7,880 (700–26,275)	12%	1%	13%	12%	0%
112	9,673 (700–33,525)	6%	0%	9%	11%	0%
106	12,095 (700–45,275)	3%	0%	5%	11%	0%
100	18,664 (700–48,775)	1%	0%	2%	8%	0%

Notes: Cells are shaded if the mean range value for the specified received level exceeds the distance cutoff range for a particular hearing group. Any impacts within the cutoff range for a criteria group are included in the estimated impacts. Cut-off ranges in this table are for activities with high source levels and/or multiple platforms (see Table 3.4-3 for behavioral cut-off distances). dB re 1 µPa = decibels referenced to 1 micropascal, MF = mid-frequency

3.4.2.1.2.3 Impacts from Sonar and Other Transducers During the Action Alternatives

Use of sonar and other transducers would typically be transient and temporary. General categories and characteristics of sonar systems and the number of hours these sonars would be operated annually during training and testing under Alternative 1 and 2 are described in Section 3.0.3.1 (Acoustic Stressors). Activities using sonars and other transducers would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activities Descriptions). The types (i.e., source bin) of sonars and other transducers to be used during each training activity and the location in the Study Area are provided in Table 2.5-1 (Current and Proposed Training Activities). The type (i.e., source bin) of sonars and other transducers to be used during each testing activity and the location in the Study Area are provided in Table 2.5-2 (Current and Proposed Naval Sea Systems Command Testing Activities) and Table 2.5-3 (Current and Proposed Naval Air Systems Command Testing Activities).

Anti-submarine warfare activities include unit-level training and testing activities, and anti-submarine warfare sonar systems would be active when conducting surface ship and submarine sonar maintenance. Submarine and surface ship sonar maintenance activities involve the use of a single system in a limited manner; therefore, significant reactions to maintenance are less likely than with most other anti-submarine warfare activities. Furthermore, sonar maintenance activities typically occur either pierside or within entrances to harbors where higher levels of anthropogenic activity, including elevated noise levels, already exist. Unit-level training activities typically involve the use of a single vessel or aircraft and last for only a few hours over a small area of ocean. These unit-level training and sonar maintenance activities are limited in scope and duration; therefore, significant behavioral reactions are less likely to occur.

Anti-submarine warfare testing activities are typically similar to unit-level training and maintenance activities. Vessel evaluation testing activities also use the same anti-submarine warfare sonars on ships and submarines. These testing activities are limited in scope and duration; therefore, many of the impacts estimated by the quantitative analysis are unlikely to rise to the level of a significant behavioral response.

Mine warfare training and testing activities typically involve a ship, helicopter, or unmanned vehicle using a mine-hunting sonar to locate mines. Most mine warfare sonar systems have a lower source level, higher frequency, and narrower, often downward facing beam pattern as compared to most anti-submarine warfare sonars. Significant reactions in marine mammals have not been reported due to exposure to mine warfare sonars. While individual animals could show short-term and minor responses to mine warfare sonar training activities, these reactions are very unlikely to lead to any costs or long-term consequences for individuals or populations.

Unmanned underwater vehicle training and testing also employ many of the same sonar systems as mine warfare testing and usually involves only a single sonar platform (i.e., unmanned underwater vehicle). Most of the sonar systems and other transducers used during these testing activities typically have a lower source level, higher-frequency, and narrower, often downward facing beam pattern as compared to most anti-submarine warfare sonars. Significant reactions in marine mammals have not been reported due to exposure to these types of systems sonars. Animals are most likely to show short-term and minor to moderate responses to these testing activities; therefore, many of the impacts estimated by the quantitative analysis are unlikely to rise to the level of a significant behavioral response. Acoustic and Oceanographic Science and Research uses a number of different sonar systems and other transducers to sense and measure the parameters of the ocean (e.g., temperature) and conduct research on the ways sound travels underwater. Many of these systems generate only moderate sound levels and are stationary. Significant reactions in marine mammals have not been reported due to exposure to the sonars and other transducers typically used in these activities. Animals are most likely to show short-term and minor to moderate responses to these testing activities; therefore, many of the impacts estimated by the quantitative analysis are unlikely to rise to the level of a significant behavioral response.

Other testing activities include testing of individual sonar systems and other transducers for performance and acoustic signature. Most sources used during these exercises have moderate source levels between 160 and 200 dB re 1 µPa @ 1m and are used for a limited duration, up to a few hours in most cases. Significant reactions in marine mammals have not been reported due to exposure to the sonars and other transducers typically used in these activities. Animals are most likely to show short-term and minor to moderate responses to these testing activities; therefore, many of the impacts estimated by the quantitative analysis are unlikely to rise to the level of a significant behavioral response.

Presentation of Estimated Impacts from the Quantitative Analysis

The results of the analysis of potential impacts on marine mammals from sonars and other transducers (Section 3.4.2.1.2.1, Methods for Analyzing Impacts from Sonars and Other Transducers) are discussed below. The numbers of potential impacts estimated for individual species and stocks of marine mammals from exposure to sonar for training and testing activities under each action alternative are shown in Appendix E (Estimated Marine Mammal and Sea Turtle Impacts from Exposure to Acoustic and Explosive Stressors under Navy Training and Testing Activities) and presented below in figures for each species of marine mammal with any estimated effects (e.g., Figure 3.4-14). The Activity Categories that are most likely to cause impacts and the most likely region in which impacts could occur are represented in the graphics for each species. There is a potential for impacts to occur anywhere within the Study Area where sound from sonar and the species overlap, although only regions or activity categories where 0.5 percent of the impacts or greater are estimated to occur are graphically represented below. All (i.e., grand total) estimated impacts for that species are included, regardless of region or category.

The predictions of numbers of marine mammals that may be affected are shown for the three subdivisions of the NWTT Study Area: the Offshore Area, Inland Waters, and Western Behm Canal (Southeast Alaska). The Inland Waters area has been further divided into the following sub-regions: Dabob Bay Range Complex, Northeast Puget Sound, and Southwest Puget Sound. Note that the numbers of activities planned under Alternative 1 can vary from year-to-year. Results are presented for a “representative sonar use year” and a “maximum sonar use year” to provide a range of potential impacts that could occur. Planned activities for Alternative 2 are more consistent from year to year so only maximum annual impacts are presented. The number of hours these sonars would be operated under each alternative are described in Section 3.0.3.1 (Acoustic Stressors).

It is important to note when examining the results of the quantitative analysis that the behavioral response functions used to predict the numbers of reactions in this analysis are largely derived from several studies (see Section 3.4.2.1.1.5, Behavioral Reactions). The best available science, including behavioral response studies, was used for deriving these criteria; however, many of the factors inherent in these studies that potentially increased the likelihood and severity of observed responses (e.g., close approaches by multiple vessels, tagging animals, and vectoring towards animals that have already begun avoiding the sound source) would not occur during Navy activities. Because the Navy purposely avoids approaching marine mammals, many of the behavioral responses estimated by the quantitative analysis are unlikely to occur or unlikely to rise to the severity observed during many of the behavioral response studies.

Although the statutory definition of Level B harassment for military readiness activities under the MMPA requires that the natural behavior patterns of a marine mammal be significantly altered or abandoned, the current state of science for determining those thresholds is somewhat unsettled. Therefore, in its analysis of impacts associated with acoustic sources, the Navy is adopting a conservative approach that overestimates the number of takes by Level B harassment. The responses estimated using the Navy’s quantitative analysis are most likely to be moderate severity. Moderate severity responses would be considered significant if they were sustained for a duration long enough that it caused an animal to be outside of normal daily variations in feeding, reproduction, resting, migration/movement, or social cohesion. As discussed in Section 3.4.2.1.2.1 (Methods for Analyzing Impacts from Sonars and Other Transducers), the behavioral response functions used within the Navy’s quantitative analysis were primarily derived from experiments using short-duration sound exposures lasting, in many cases, for less than 30 minutes. If animals exhibited moderate severity reactions for the duration of the exposure or longer, then it was conservatively assumed that the animal experienced a significant behavioral reaction. However, the experiments did not include measurements of costs to animals beyond the immediately observed reactions, and no direct correlations exist between an observed behavioral response and a cost that may result in long-term consequences. Within the Navy's quantitative analysis, many behavioral reactions are estimated from exposure to sound that may exceed an animal's behavioral threshold for only a single exposure up to several minutes. It is likely that many of the estimated behavioral reactions within the Navy's quantitative analysis would not constitute significant behavioral reactions; however, the numbers of significant verses non-significant behavioral reactions are currently impossible to predict. Consequently, there is a high likelihood that significant numbers of marine mammals exposed to acoustic sources are not significantly altering or abandoning their natural behavior patterns. As such, the overall impact of acoustic sources from military readiness activities on marine mammal species and stocks is negligible (i.e., cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stocks through effects on annual rates of recruitment or survival).

Mysticetes

Mysticetes may be exposed to sound from sonar and other transducers associated with training and testing activities throughout the year, although many species are not present in the NWTT Study Area in the summer months. Most low- (less than 1 kHz) and mid- (1–10 kHz) frequency sonars and other transducers produce sounds that are likely to be within the hearing range of mysticetes (Section 3.4.1.6, Hearing and Vocalization). Some high-frequency sonars (greater than 10 kHz) also produce sounds that should be audible to mysticetes, although only smaller species of mysticetes such as minke whales are likely to be able to hear higher frequencies, presumably up to 30 kHz. Therefore, some high-frequency sonars and other transducers with frequency ranges between 10 and 30 kHz may also be audible to some mysticetes. If a sound is within an animal's hearing range then behavioral reactions, physiological stress, masking and hearing loss are potential impacts that must be analyzed. If a marine mammal cannot hear a sound, then behavioral reactions, physiological stress, masking, or hearing loss is not likely to occur. Impact ranges for mysticetes are discussed under low-frequency cetaceans in Section 3.4.2.1.2 (Impacts from Sonar and Other Transducers).

Behavioral reactions in mysticetes resulting from exposure to sonar could occur based on the quantitative analysis. Considering best available data on observed mysticete responses to sound exposure, behavioral responses would not be expected to occur beyond 20 km from events with multiple sound source platforms or high source levels, nor beyond 10 km from moderate source level, single platform events. Any predicted behavioral reactions are much more likely to occur within a few kilometers of the sound source. As discussed above in *Assessing the Severity of Behavioral Responses from Sonar* and *other Transducers*, the quantitative analysis very likely overestimated the numbers of behavioral reactions due to the underlying nature of the data used to derive the behavioral response functions. Research shows that if mysticetes do respond they may react in a number of ways, depending on the characteristics of the sound source, their experience with the sound source, and whether they are migrating or on seasonal grounds (i.e., breeding or feeding). Behavioral reactions may include alerting, breaking off feeding dives and surfacing, or diving or swimming away. Overall, mysticetes have been observed to be more reactive to acoustic disturbance when a noise sources is located directly on their migration route. Mysticetes disturbed while migrating could pause their migration or route around the disturbance. Animals disturbed while engaged in other activities such as feeding or reproductive behaviors may be more likely to ignore or tolerate the disturbance and continue their natural behavior patterns. Therefore, behavioral reactions from mysticetes are likely to be short-term and low to moderate severity.

Some mysticetes may avoid a larger activity such as a major training exercise as it moves through an area. Vessels and aircraft associated with training activities are typically in transit during an event (they are not stationary) and activities typically do not use the same training locations day after day during multi-day activities. If an event otherwise focuses on a fixed location, mysticetes may avoid the location of the activity for the duration of the event. If animals are displaced, they would likely return quickly after the event subsides. In the ocean, the use of sonar and other transducers is transient and is unlikely to expose the same population of animals repeatedly over a short period except around homeports and fixed instrumented ranges, which are not present in this Study Area. Overall, a few behavioral reactions per year by a single individual are unlikely to produce long-term consequences for that individual.

Behavioral research indicates that mysticetes most likely avoid sound sources at levels that would cause any hearing loss (i.e., TTS) (Section 3.4.2.1.1.5, Behavioral Reactions). Therefore, it is likely that the quantitative analysis overestimates TTS in marine mammals because it does not account for animals avoiding sound sources at closer ranges. Mysticetes that do experience PTS or TTS from sonar sounds may have reduced ability to detect biologically important sounds around the frequency band of the sonar until their hearing recovers. Recovery from hearing loss begins almost immediately after the noise exposure ceases and can take a few minutes to a few days to fully recover, depending on the magnitude of the initial TS. TTS would be recoverable and PTS would leave some residual hearing loss. Most TTS, if it does actually occur, would be more likely to be minor to moderate (i.e., less than 20 dB of TTS directly after the exposure) and would recover within a matter of minutes to hours (see Section 3.4.2.1.1.2, Hearing Loss). Threshold shifts do not necessarily affect all hearing frequencies equally, and typically manifest themselves at the exposure frequency or within an octave above the exposure frequency. During the period that a mysticete had hearing loss, social calls from conspecifics could be more difficult to detect or interpret if they fell in the octave band of the sonar frequency. Killer whales are a primary predator of mysticetes. Some hearing loss could make killer whale calls more difficult to detect at farther ranges until hearing recovers. It is unclear how or if mysticetes use sound for finding prey or feeding; therefore, it is unknown whether hearing loss would affect a mysticete's ability to locate prey or rate of feeding. A single or even a few minor TTS (less than 20 dB of TTS) to an individual mysticete per year are unlikely to have any long-term consequences for that individual.

Research and observations of masking in marine mammals are discussed in Section 3.4.2.1.1.4 (Masking). Most anti-submarine warfare sonars and countermeasures use mid-frequency ranges and a few use low-frequency ranges. Most of these sonar signals are limited in the temporal, frequency, and spatial domains. The duration of most individual sounds is short, lasting up to a few seconds each. Systems typically operate with low-duty cycles for most tactical sources, but some systems may operate nearly continuously or with higher duty cycles. Nevertheless, masking may be more prevalent at closer ranges to these high-duty cycle and continuous active sonar systems. Most anti-submarine warfare activities are geographically dispersed and last for only a few hours, often with intermittent sonar use even within this period. Most anti-submarine warfare sonars also have a narrow frequency band (typically less than one-third octave). These factors reduce the likelihood of sources causing significant masking in mysticetes. High-frequency (greater than 10 kHz) sonars fall outside of the best hearing and vocalization ranges of mysticetes (see Section 3.4.1.6, Hearing and Vocalization). Furthermore, high frequencies (above 10 kHz) attenuate more rapidly in the water due to absorption than do lower frequency signals, thus producing only a small zone of potential masking. High-frequency sonars are typically used for mine hunting, navigation, and object detection (avoidance). Masking in mysticetes due to exposure to high-frequency sonar is unlikely. Potential costs to mysticetes from masking are similar to those discussed above for mild to moderate levels of TTS, with the primary difference being that the effects of masking are only present when the sound source (i.e., sonar) is actively pinging and the effect is over the moment the sound has ceased. By contrast, hearing loss lasts beyond the exposure for a period. Nevertheless, mysticetes that do experience some masking for a short period from low- or mid-frequency sonar may have their ability to communicate with conspecifics reduced, especially at further ranges. However, larger mysticetes (e.g., blue whale, fin whale, sei whale) communicate at frequencies below those of mid-frequency sonar and even most low-frequency sonars. Mysticetes that communicate at higher frequencies (e.g., minke whale) may be affected by some short-term and intermittent masking. Sounds from mid-frequency sonar could mask killer whale vocalizations making them more difficult to detect, especially at further ranges. It is unknown whether masking would affect a mysticete's ability to feed since it is unclear how or if mysticetes use sound for finding prey or feeding. A single or even a few short periods of masking, if it were to occur, to an individual mysticete per year are unlikely to have any long-term consequences for that individual.

Many activities such as submarine under ice certification and most mine hunting exercises use only high-frequency sonars that are not within mysticetes' hearing range; therefore, there were no predicted effects. Section 3.4.1.6 (Hearing and Vocalization) discusses low-frequency cetacean (i.e., mysticetes) hearing abilities.

North Pacific Right Whales (Endangered Species Act-Listed)

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

North Pacific right whales are extremely rare in the Study Area. North Pacific right whales could be present in the Offshore Area portion of the Study Area, but there is no evidence to indicate the presence of North Pacific right whales in the Inland Waters portion. Data on right whale presence is insufficient to develop density estimates for use in the Navy Acoustic Effects Model for estimating the number of animals that may be exposed to sonars and other transducers. As described in Section 3.1.1.3 (Distribution), due to its rare presence in the Study Area, the potential for this species to be exposed to and affected by sounds from sonar and other transducers is extremely low.

Based on the factors described above, as well as the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), exposure of any North Pacific right whales to sonars and other transducers associated with training activities is highly unlikely. Thus, long-term consequences for the species would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 would not result in the incidental taking of North Pacific right whales.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 1 may affect ESA-listed North Pacific right whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

North Pacific right whales are extremely rare in the Study Area. North Pacific right whales could be present in the Offshore Area portion of the Study Area, but there is no evidence to indicate the presence of North Pacific right whales in either the Inland Waters or the Western Behm Canal portions. Data on right whale presence is insufficient to develop density estimates for use in the Navy Acoustic Effects Model for estimating the number of animals that may be exposed to sonars and other transducers. As described in Section 3.1.1.3 (Distribution), due to its rare presence in the Study Area, the potential for this species to be exposed to and affected by sounds from sonar and other transducers in is extremely low.

Based on the factors described above, as well as the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), exposure of any North Pacific right whales to sonars and other transducers associated with testing activities is highly unlikely. Thus, long-term consequences for the species would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 would not result in the incidental taking of North Pacific right whales.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 1 may affect ESA-listed North Pacific right whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

North Pacific right whales are extremely rare in the Study Area. North Pacific right whales could be present in the Offshore Area portion of the Study Area, but there is no evidence to indicate the presence of North Pacific right whales in the Inland Waters portion. Data on right whale presence is insufficient to develop density estimates for use in the Navy Acoustic Effects Model for estimating the number of animals that may be exposed to sonars and other transducers. As described in Section 3.1.1.3 (Distribution), due to its rare presence in the Study Area, the potential for this species to be exposed to and affected by sounds from sonar and other transducers in is extremely low.

Based on the factors described above, as well as the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), exposure of any North Pacific right whales to sonars and other transducers associated with training activities is highly unlikely. Thus, long-term consequences for the species would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 would not result in the incidental taking of North Pacific right whales.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 2 may affect ESA-listed North Pacific right whales.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

North Pacific right whales are extremely rare in the Study Area. North Pacific right whales could be present in the Offshore Area portion of the Study Area, there is no evidence to indicate the presence of North Pacific right whales in either the Inland Waters or the Western Behm Canal. Data on right whale presence is insufficient to develop density estimates for use in the Navy Acoustic Effects Model for estimating the number of animals that may be exposed to sonars and other transducers. As described in Section 3.1.1.3 (Distribution), due to its rare presence in the Study Area, the potential for this species to be exposed to and affected by sounds from sonar and other transducers in is extremely low.

Based on the factors described above, as well as the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), exposure of any North Pacific right whales to sonars and other transducers associated with testing activities is highly unlikely. Thus, long-term consequences for the species would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 would not result in the incidental taking of North Pacific right whales.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 2 may affect ESA-listed North Pacific right whales.

Blue Whales (Endangered Species Act-Listed)

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Blue whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. Blue whales could be present in the Offshore Area portion of the Study Area, but are not expected to occur in the Inland Waters portion. The quantitative analysis estimates behavioral reactions under Alternative 1 (Figure 3.4-14 and Table 3.4-15). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Eastern North Pacific Stock (Table 3.4-15).

As described for mysticetes above, even a few minor to moderate behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of blue whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 1 may affect ESA-listed blue whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Blue whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. Blue whales could be present in the Offshore Area portion of the Study Area, but are not expected to occur in the Inland Waters or Western Behm Canal portions. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-14 and Table 3.4-15). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Eastern North Pacific Stock (Table 3.4-15).

As described for mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of blue whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 1 may affect ESA-listed blue whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-14: Blue Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-15: Estimated Impacts on Individual Blue Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Eastern North Pacific	2	0	0	3	4	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Blue whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. Blue whales could be present in the Offshore Area portion of the Study Area, but are not expected to occur in the Inland Waters portion. The quantitative analysis estimates behavioral reactions under Alternative 2 (Figure 3.4-15 and Table 3.4-16). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Eastern North Pacific stock (Table 3.4-16).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of blue whales incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 2 may affect ESA-listed blue whales.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Blue whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. Blue whales could be present in the Offshore Area portion of the Study Area, but are not expected to occur in the Inland Waters or Western Behm Canal portions. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-15 and Table 3.4-16). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Eastern North Pacific stock (Table 3.4-16).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of blue whales incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 2 may affect ESA-listed blue whales.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-15: Blue Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-16: Estimated Impacts on Individual Blue Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Eastern North Pacific	2	0	0	4	5	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Fin Whales (Endangered Species Act-Listed)

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Fin whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. Fin whales could be present year round in the Offshore Area, but are not expected to occur in the Inland Waters portion of the Study Area. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-16 and Table 3.4-17). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-17).

As described for mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of fin whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 1 may affect ESA-listed fin whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Fin whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. Fin whales could be present year round in the Offshore Area and occur in small-numbers in the Western Behm Canal, but are not expected to occur in the Inland Waters portion of the Study Area. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-16 and Table 3.4-17). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-17).

As described for mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of fin whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 1 may affect ESA-listed fin whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-16: Fin Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-17: Estimated Impacts on Individual Fin Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Northeast Pacific	0	0	0	1	1	0
California, Oregon, & Washington	41	13	0	44	29	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Fin whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. Fin whales could be present year round in the Offshore Area, but are not expected to occur in the Inland Waters portion of the Study Area. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-17 and Table 3.4-18). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-18).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of fin whales incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 2 may affect ESA-listed fin whales.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Fin whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. Fin whales could be present year round in the Offshore Area and occur in small-numbers in the Western Behm Canal, but are not expected to occur in the Inland Waters portion of the Study Area. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-17 and Table 3.4-18). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-18).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of fin whales incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 2 may affect ESA-listed fin whales.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-17: Fin Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-18: Estimated Impacts on Individual Fin Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Northeast Pacific	0	0	0	1	1	0
California, Oregon, & Washington	42	13	0	58	35	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Sei Whales (Endangered Species Act-Listed)

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Sei whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. Sei whales could be present in the Offshore Area portion of the Study Area, but are not expected to occur in the Inland Waters portion. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-18 and Table 3.4-19). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Eastern North Pacific stock (Table 3.4-19).

As described for mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of sei whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 1 may affect ESA-listed sei whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Sei whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. Sei whales could be present in the Offshore Area portion of the Study Area, but are not expected to occur in the Inland Waters or Western Behm Canal portions. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-18 and Table 3.4-19). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Eastern North Pacific stock (Table 3.4-19).

As described for mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of sei whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 1 may affect ESA-listed sei whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-18: Sei Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-19: Estimated Impacts on Individual Sei Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Eastern North Pacific	16	14	0	16	35	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Sei whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. Sei whales could be present in the Offshore Area portion of the Study Area, but are not expected to occur in the Inland Waters portion. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-19 and Table 3.4-20). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Eastern North Pacific stock (Table 3.4-20).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of sei whales incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 2 may affect ESA-listed sei whales.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Sei whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. Sei whales could be present in the Offshore Area portion of the Study Area, but are not expected to occur in the Inland Waters or Western Behm Canal portions. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-19 and Table 3.4-20). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Eastern North Pacific stock (Table 3.4-20).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of sei whales incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 2 may affect ESA-listed sei whales.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-19: Sei Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-20: Estimated Impacts on Individual Sei Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Eastern North Pacific	16	14	0	21	43	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Minke Whales

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Minke whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-20 and Table 3.4-21). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-21).

As described for mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

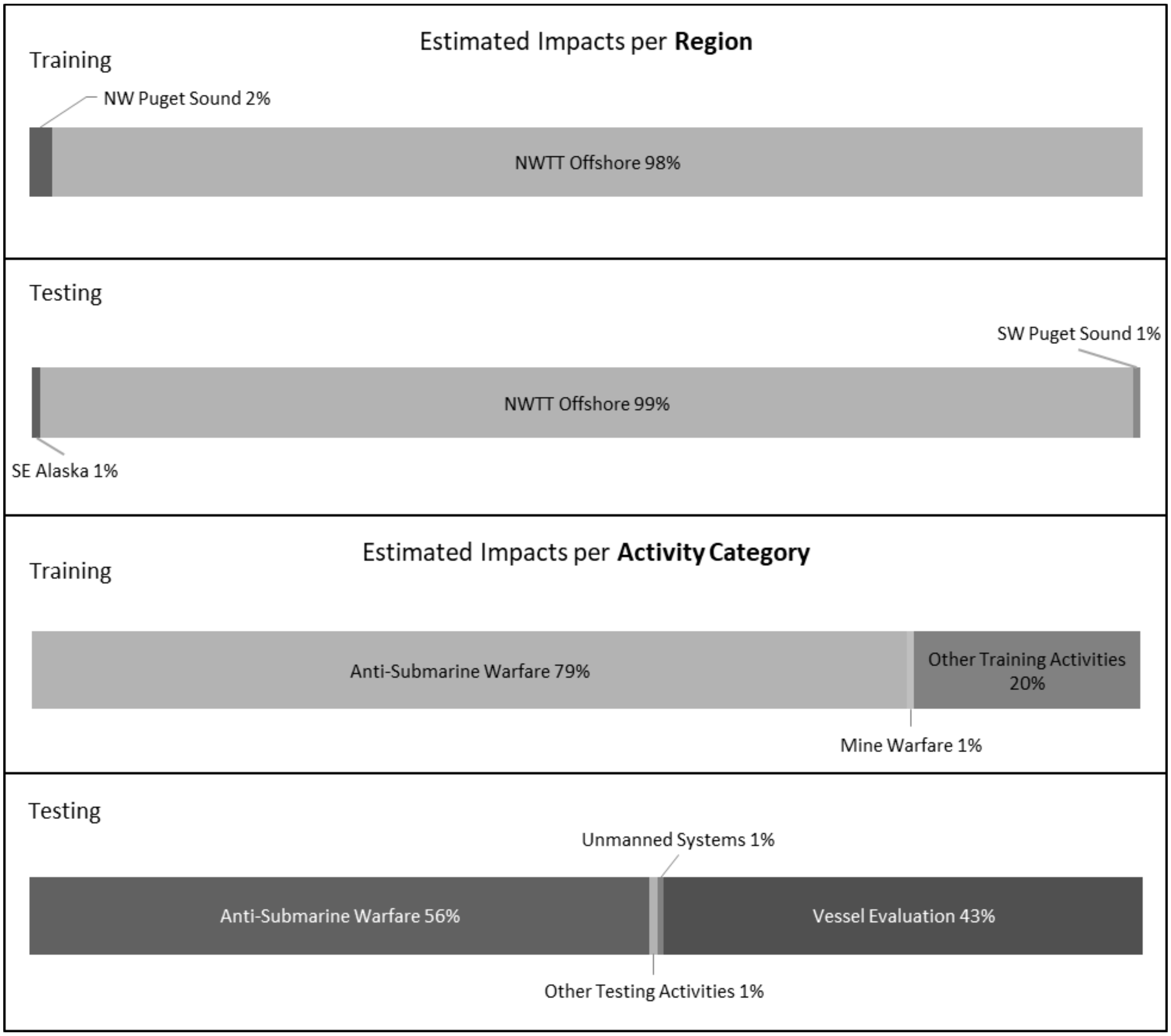
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of minke whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Minke whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-20 and Table 3.4-21). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-21).

As described for mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of minke whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-20: Minke Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-21: Estimated Impacts on Individual Minke Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Alaska	0	0	0	1	1	0
California, Oregon, & Washington	52	58	0	55	131	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Minke whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-21 and Table 3.4-22). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-22).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of minke whales incidental to those activities.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Minke whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-21 and Table 3.4-22). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-22).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of minke whales incidental to those activities.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-21: Minke Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-22: Estimated Impacts on Individual Minke Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Alaska	0	0	0	1	1	0
California, Oregon, & Washington	54	58	0	70	166	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Humpback Whales (some DPSs are Endangered Species Act-Listed)

Impacts have been modeled for the Hawaii (Central North Pacific stock) population of humpback whales, which are not Endangered Species Act-Listed, and for the Mexico (California, Oregon, and Washington stock), and Central America (California, Oregon, and Washington stock populations of humpback whales, which are Endangered Species Act listed. Western North Pacific humpback whales are not likely to be present in the Study Area during or in proximity to any of the proposed training or testing activities.

Three humpback whale feeding areas have been identified as biologically important areas (Aquatic Mammals, 2015; Calambokidis et al., 2015) in the Offshore Area portion of the Study Area. In addition to procedural mitigation, the Navy developed the following mitigation areas to avoid or reduce potential impacts from sonar and other transducers on humpback whales in their important feeding habitats and within the proposed humpback whale critical habitat, as described in Appendix K (Geographic Mitigation Assessment):

- **Stonewall and Heceta Bank Humpback Whale Mitigation Area**. The portion of the Stonewall and Heceta Bank biologically important feeding area that falls within the Study Area is encompassed by the Stonewall and Heceta Bank Humpback Whale Mitigation Area. This mitigation area also overlaps proposed humpback whale critical habitat. In this mitigation area, the Navy will not use surface ship hull-mounted MF1 mid-frequency active sonar during training and testing from May 1 to November 30.
- **Point St. George Humpback Whale Mitigation Area**. The portion of the Point St. George biologically important feeding area that falls within the Study Area is encompassed by the Point St. George Humpback Whale Mitigation Area. This mitigation area also overlaps proposed humpback whale critical habitat. In this mitigation area, the Navy will not use surface ship hull-mounted MF1 mid-frequency active sonar during training and testing from July 1 to November 30.
- **Olympic Coast National Marine Sanctuary Mitigation Area**. The Olympic Coast National Marine Sanctuary Mitigation Area overlaps a significant portion of the biologically important humpback whale feeding area off northern Washington, as well as proposed humpback whale critical habitat. Within this mitigation area, the Navy will conduct a maximum of 32 hours of surface ship hull-mounted MF1 mid-frequency active sonar during training annually.

- **Marine Species Coastal Mitigation Area**. The Marine Species Coastal Mitigation Area encompasses the biologically important humpback whale feeding area off northern Washington, as well as proposed humpback whale critical habitat. Within 50 NM from shore in this mitigation area, the Navy will issue annual seasonal awareness notification messages to alert ships and aircraft to the possible presence of increased seasonal concentrations of humpback whales. For safe navigation and to avoid interactions with large whales, the Navy will instruct vessels to remain vigilant to the presence of humpback whales that may be vulnerable to potential impacts from training and testing activities. Platforms will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation. Within 12 NM from shore in this mitigation area, the Navy will not conduct Anti-Submarine Warfare Tracking Exercise – Helicopter, – Maritime Patrol Aircraft, – Ship, or – Submarine training activities (which involve the use of mid-frequency or high-frequency active sonar), or non-explosive Anti-Submarine Warfare Torpedo Exercise – Submarine training activities (which also involve the use of mid-frequency or high-frequency active sonar).
- **Olympic Coast National Marine Sanctuary Mitigation Area, Juan de Fuca Eddy Marine Species Mitigation Area, and 20 NM From Shore in the Marine Species Coastal Mitigation Area.** The Juan de Fuca Eddy Marine Species Mitigation Area overlaps an important humpback whale feeding area off Cape Flattery. The important habitats that overlap the other mitigation areas are identified in bullets above. Within these combined mitigation areas, the Navy will conduct a maximum combined total of 33 hours of surface ship hull-mounted MF1 mid-frequency active sonar during testing annually.

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Humpback whales are present year round in the Offshore Area and seasonally in the Inland Waters portion of the Study Area, where they may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-22 and Table 3.4-23). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-23).

As described for mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Sound from sonars and other transducers during training activities would overlap proposed critical habitat for the ESA-listed Central America and Mexico DPSs of humpback in the Offshore Area. As described in Section 3.4.1.13 (Humpback Whale [*Megaptera novaeangliae*]), one essential feature was identified for humpback whale critical habitat, and that essential feature is defined as prey species, primarily euphausiids and small pelagic schooling fishes, of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth. This essential feature would not be adversely affected by sonar use proposed in this action, as follows:

- In the Offshore Area, the humpback whales' diet is consistently dominated by euphausiids and small pelagic fishes, such as northern anchovy, Pacific herring, Pacific sardine, and capelin

(Fleming et al., 2016; Gabriele et al., 2017; Keen et al., 2017; Santora et al., 2010; Straley et al., 2017; Szabo, 2015; Witteveen & Wynne, 2017). As described in the Fishes (3.9) and Marine Invertebrates (3.8) Acoustic Stressor sections, non-impulsive sound sources, such as sonar and other transducers, have not been known to cause direct injury or mortality to fish under conditions that would be found in the wild (Halvorsen et al., 2012; Kane et al., 2010; Popper et al., 2007) and would only be expected to result in behavioral reactions or potential masking in marine invertebrates. Most sources proposed for use during training activities overlapping or adjacent to critical habitat in the Study Area would not fall within the frequency range of marine invertebrate or fish hearing, thereby presenting no plausible route of effect on either species. The few sources used within invertebrate and fish hearing range would be limited and typically transient, as shown in Appendix A (Navy Activities Descriptions) and examined in Section 3.9.3.1.2 (Impacts from Sonar and Other Transducers) of the Fishes section (3.9). Additionally, this proposed use of sonars would not chronically elevate background noise causing a reduction in foraging space in critical habitat for humpback whales. Brief periods of masking due to spatially and temporally isolated exposures are accounted for in the quantitative assessment of the potential for direct behavioral disturbance as a level-based response as explained in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017b).

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of humpback whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 1 may affect ESA-listed humpback whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA. The use of sonar and other transducers during training activities would have no effect on proposed critical habitat for the Central America and Mexico DPSs of humpback whale.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Humpback whales are present year round in the Offshore Area and Western Behm Canal, and seasonally in the Inland Waters portion of the Study Area, where they may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-22 and Table 3.4-23). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-23).

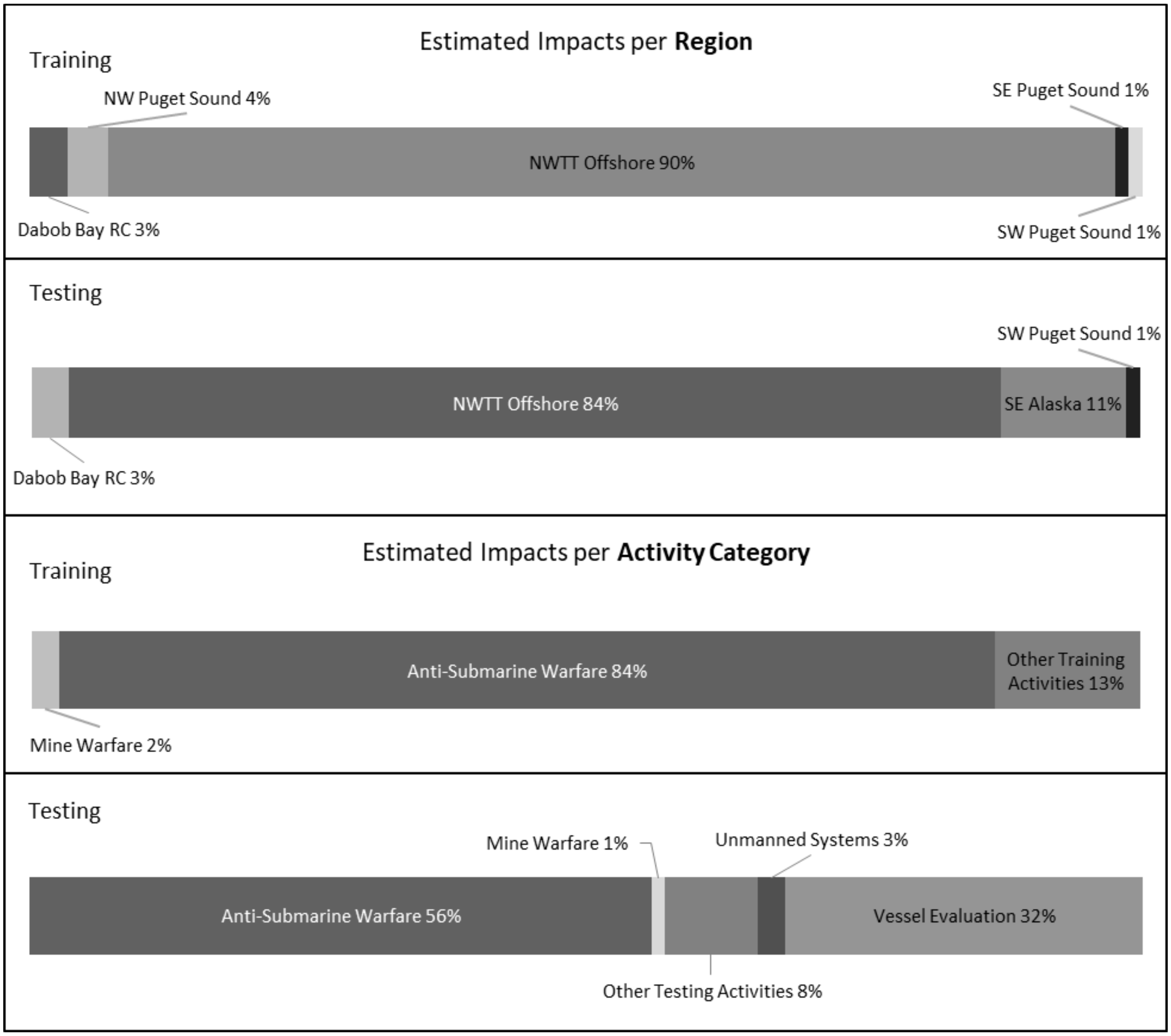
As described for mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Sound from sonars and other transducers during testing activities would overlap proposed critical habitat for the ESA-listed Central America and Mexico DPSs of humpback in the Offshore Area. As described in Section 3.4.1.13 (Humpback Whale [*Megaptera novaeangliae*]), one essential feature was identified for humpback whale critical habitat, and that essential feature is defined as prey species, primarily euphausiids and small pelagic schooling fishes, of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth. This essential feature would not be adversely affected by sonar use proposed in this action, as follows:

In the Offshore Area, the humpback whales' diet is consistently dominated by euphausiids and small pelagic fishes, such as northern anchovy, Pacific herring, Pacific sardine, and capelin (Fleming et al., 2016; Gabriele et al., 2017; Keen et al., 2017; Santora et al., 2010; Straley et al., 2017; Szabo, 2015; Witteveen & Wynne, 2017). As described in the Fishes (3.9) and Marine Invertebrates (3.8) Acoustic Stressor sections, non-impulsive sound sources, such as sonar and other transducers, have not been known to cause direct injury or mortality to fish under conditions that would be found in the wild (Halvorsen et al., 2012; Kane et al., 2010; Popper et al., 2007) and would only be expected to result in behavioral reactions or potential masking in marine invertebrates. Most sources proposed for use during testing activities overlapping or adjacent to critical habitat in the Study Area would not fall within the frequency range of marine invertebrate or fish hearing, thereby presenting no plausible route of effect on either species. The few sources used within invertebrate and fish hearing range would be limited and typically transient, as shown in Appendix A (Navy Activities Descriptions) and examined in Section 3.9.3.1.2 (Impacts from Sonar and Other Transducers) of the Fishes section (3.9). Additionally, this proposed use of sonars would not chronically elevate background noise causing a reduction in foraging space in critical habitat for humpback whales. Brief periods of masking due to spatially and temporally isolated exposures are accounted for in the quantitative assessment of the potential for direct behavioral disturbance as a level-based response as explained in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017b).

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of humpback whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 1 may affect ESA-listed humpback whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA. The use of sonar and other transducers during testing activities would have no effect on proposed critical habitat for the Central America and Mexico DPSs of humpback whale.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-22: Humpback Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-23: Estimated Impacts on Individual Humpback Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Central North Pacific	3	2	0	44	65	0
California, Oregon, & Washington	3	1	0	36	51	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

<u>Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities</u>

Humpback whales are present year round in the Offshore Area and seasonally in the Inland Waters portion of the Study Area, where they may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-23 and Table 3.4-24). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-24).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of humpback whales incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 2 may affect ESA-listed humpback whales. The use of sonar and other transducers during training activities would have no effect on proposed critical habitat for the Central America and Mexico DPSs of humpback whale.

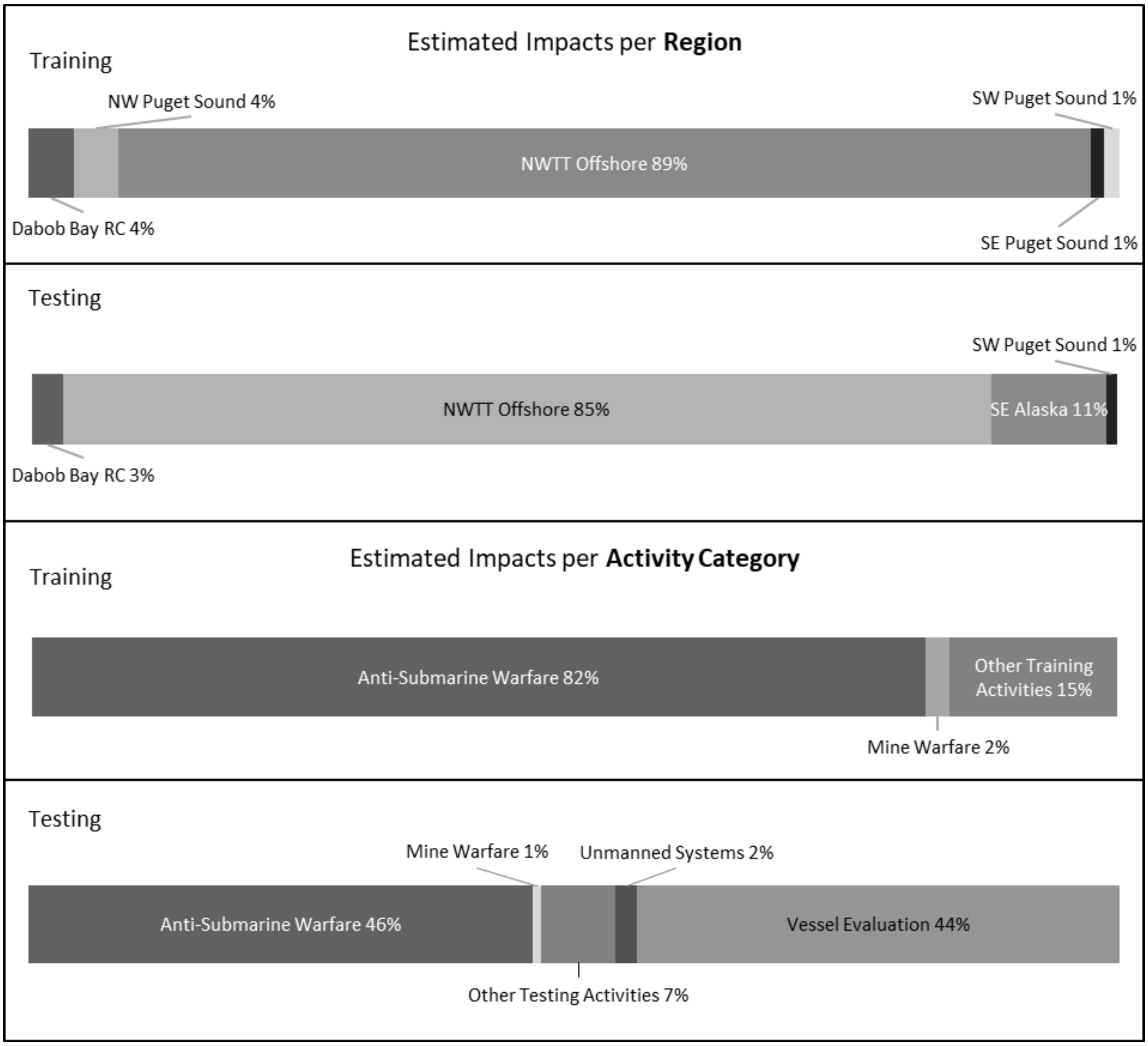
<u>Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities</u>

Humpback whales are present year round in the Offshore Area and Western Behm Canal and seasonally in the Inland Waters portion of the Study Area, where they may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-23 and Table 3.4-24). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-24).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of humpback whales incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 2 may affect ESA-listed humpback whales. The use of sonar and other transducers during testing activities would have no effect on proposed critical habitat for the Central America and Mexico DPSs of humpback whale.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-23: Humpback Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-24: Estimated Impacts on Individual Humpback Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Central North Pacific	3	2	0	55	83	0
California, Oregon, & Washington	3	2	0	44	65	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Gray Whales (one DPS is Endangered Species Act-Listed)

The vast majority of gray whales in the Study Area are from the non-endangered Eastern North Pacific stock. On very rare occasions, Western North Pacific gray whales, which are ESA-Listed, occur in the Study Area. Gray whales are present primarily from May to November in the Offshore Area, and March to May in the Inland Waters portions of the Study Area. Gray whales are considered extralimital in the Western Behm Canal.

Two gray whale feeding areas and one gray whale migration area have been identified as biologically important areas in the Offshore Area portion of the Study Area. In addition to procedural mitigation, the Navy developed the following mitigation areas to avoid or reduce potential impacts from sonar and other transducers on gray whales in their important feeding and migration habitats, as described in Appendix K (Geographic Mitigation Assessment):

- **Marine Species Coastal Mitigation Area**. The Marine Species Coastal Mitigation Area overlaps a portion of the biologically important gray whale feeding area off northwest Washington and biologically important gray whale migration area in the NWTT Offshore Area. Within 50 NM from shore in this mitigation area, the Navy will issue annual seasonal awareness notification messages to alert ships and aircraft to the possible presence of increased concentrations of gray whales. For safe navigation and to avoid interactions with large whales, the Navy will instruct vessels to remain vigilant to the presence of gray whales that may be vulnerable to potential impacts from training and testing activities. Platforms will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation. Within 12 NM from shore in this mitigation area, the Navy will not conduct Anti-Submarine Warfare Tracking Exercise – Helicopter, – Maritime Patrol Aircraft, – Ship, or – Submarine training activities (which involve the use of mid-frequency or high-frequency active sonar), or non-explosive Anti-Submarine Warfare Torpedo Exercise – Submarine training activities (which also involve the use of mid-frequency or high-frequency active sonar).
- **Olympic Coast National Marine Sanctuary Mitigation Area**. The Olympic Coast National Marine Sanctuary Mitigation Area overlaps a portion of the biologically important gray whale feeding area off northwest Washington and biologically important gray whale migration area in the

NWTT Offshore Area. Within this mitigation area, the Navy will conduct a maximum of 32 hours of surface ship hull-mounted MF1 mid-frequency active sonar during training annually.

- **Olympic Coast National Marine Sanctuary Mitigation Area, Juan de Fuca Eddy Marine Species Mitigation Area, and 20 NM From Shore in the Marine Species Coastal Mitigation Area.** The Juan de Fuca Eddy Marine Species Mitigation Area overlaps gray whale migration habitat off Cape Flattery. The important habitats that overlap the other mitigation areas are identified in bullets above. Within these combined mitigation areas, the Navy will conduct a maximum combined total of 33 hours of surface ship hull-mounted MF1 mid-frequency active sonar during testing annually.
- **Northern Puget Sound Gray Whale Mitigation Area**. The Northern Puget Sound biologically important feeding area is encompassed by the Northern Puget Sound Gray Whale Mitigation Area. The mitigation area also overlaps the biologically important gray whale migration area in NWTT Inland Waters. In this mitigation area, the Navy will not conduct Civilian Port Defense – Homeland Security Anti-Terrorism/Force Protection Exercises (which involve the use of high-frequency active sonar) from March 1 to May 31.
- **Puget Sound and Strait of Juan de Fuca Mitigation Area**. The Puget Sound and Strait of Juan de Fuca Mitigation Area encompasses all NWTT Inland Waters and overlaps the biologically important gray whale migration and feeding areas in that portion of the Study Area. Within this mitigation area, the Navy will implement the following mitigation measures for active sonar that are likely to avoid or reduce potential impacts on gray whales:
    - The Navy will not use low-frequency, mid-frequency, or high-frequency active sonar during training or testing within the Puget Sound and Strait of Juan de Fuca Mitigation Area, unless a required element necessitates that the activity be conducted in NWTT Inland Waters during (1) Unmanned Underwater Vehicle Training, (2) Civilian Port Defense – Homeland Security Anti-Terrorism/Force Protection Exercises, (3) activities conducted at designated Naval Sea Systems Command testing sites, and (4) pierside sonar maintenance or testing at designated locations.
    - The Navy will use the lowest active sonar source levels practical to successfully accomplish each event.
    - Naval units will obtain permission from the appropriate designated Command authority prior to commencing pierside maintenance or testing with hull-mounted mid-frequency active sonar.
    - Navy event planners will coordinate with Navy biologists during the event planning process prior to Civilian Port Defense – Homeland Security Anti-Terrorism/Force Protection Exercises (which involve the use of high-frequency active sonar). Navy biologists will work with NMFS and will initiate communication with the appropriate marine mammal detection networks to determine the likelihood of gray whale presence in the planned training location. To the maximum extent practicable, Navy planners will use this information when planning specific details of the event (e.g., timing, location, duration) to avoid planning activities in locations or seasons where gray whale presence is expected. The Navy will ensure environmental awareness of event participants. Environmental awareness will help alert participating crews to the possible presence of applicable species in the training location. Lookouts will use the information to assist

visual observation of applicable mitigation zones and to aid in the implementation of procedural mitigation.

- The Navy will issue annual seasonal awareness notification messages to alert ships and aircraft operating within the Puget Sound and Strait of Juan de Fuca Mitigation Area to the possible presence of seasonal concentrations of gray whales in the Strait of Juan de Fuca and northern Puget Sound. For safe navigation and to avoid interactions with large whales, the Navy will instruct vessels to remain vigilant to the presence of gray whales that may be vulnerable to vessel strikes or potential impacts from training and testing activities. Platforms will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation.

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Gray whales present in the Study Area may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. Gray whales are present primarily from May to November in the Offshore Area, and March to May in the Inland Waters portions of the Study Area. The quantitative analysis estimates behavioral reactions under Alternative 1 (Figure 3.4-24 and Table 3.4-25). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Eastern North Pacific stock (Table 3.4-25).

As described for mysticetes above, even a few minor to moderate behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of gray whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 1 may affect ESA-listed gray whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

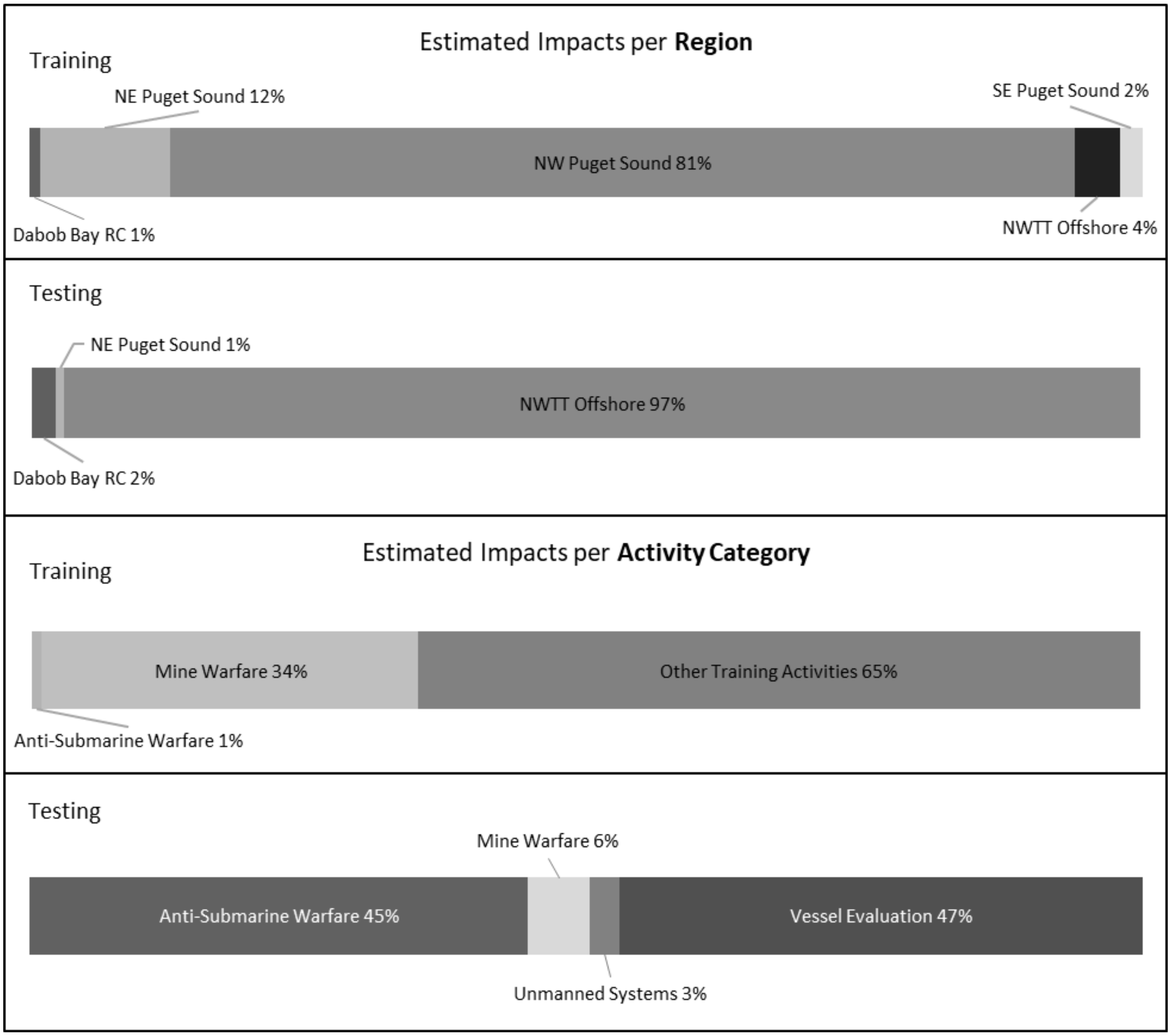
Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Gray whales present in the Study Area may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. Gray whales are present primarily from May to November in the Offshore Area, March to May in the Inland Waters portions of the Study Area, and are considered extralimital in the Western Behm Canal. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-24 and Table 3.4-25). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Eastern North Pacific stock (Table 3.4-25).

As described for mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of gray whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 1 may affect ESA-listed gray whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-24: Gray Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-25: Estimated Impacts on Individual Gray Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Eastern North Pacific	2	0	0	25	13	0
Western North Pacific	0	0	0	0	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Gray whales present in the Study Area may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. Gray whales are present primarily from May to November in the Offshore Area, and March to May in the Inland Waters portions of the Study Area. The quantitative analysis estimates behavioral reactions under Alternative 2 (Figure 3.4-25 and Table 3.4-26). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Eastern North Pacific stock (Table 3.4-26).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of gray whales incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 2 may affect ESA-listed gray whales.

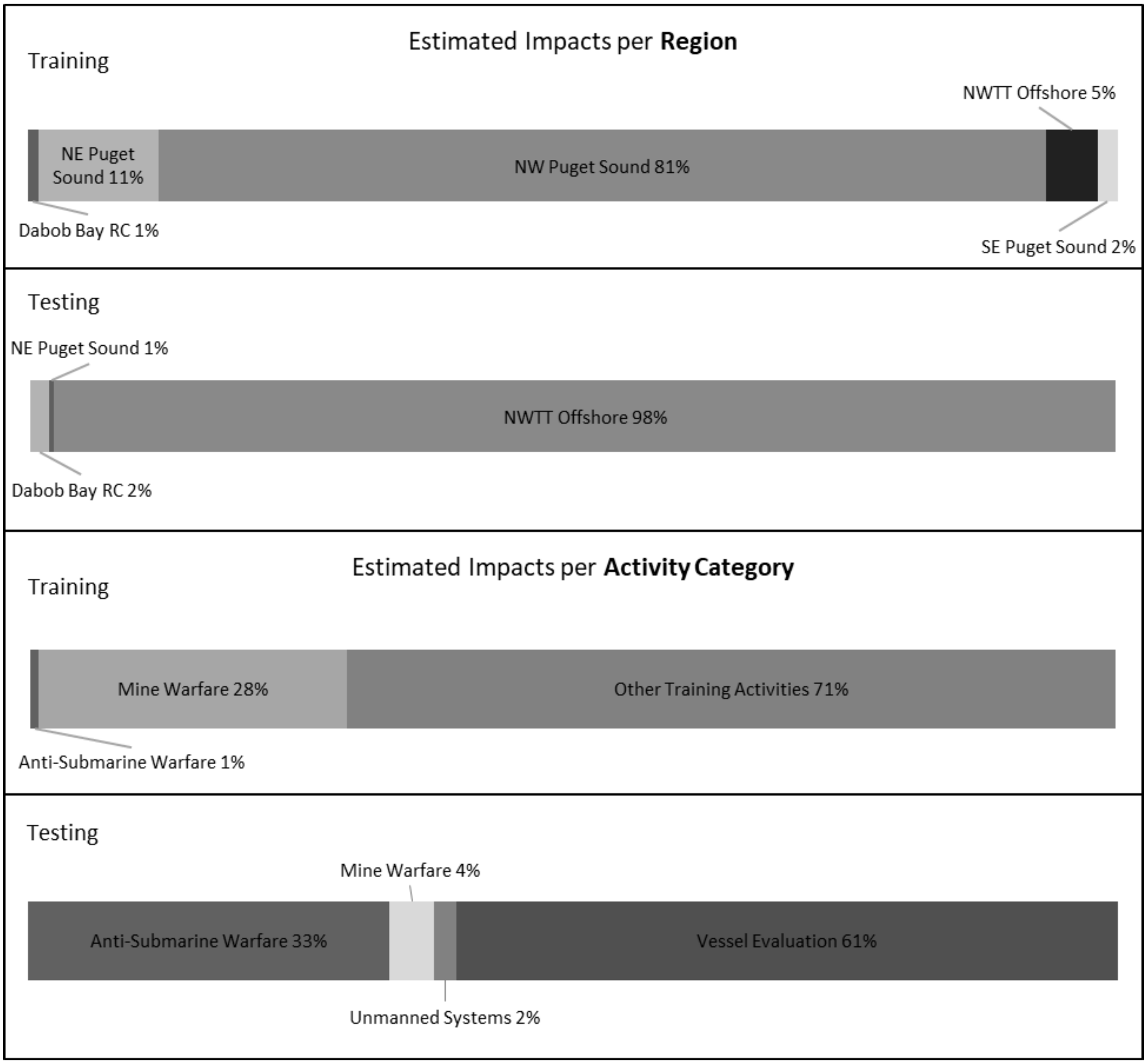
Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Gray whales present in the Study Area may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. Gray whales are present primarily from May to November in the Offshore Area, March to May in the Inland Waters portions of the Study Area, and are considered extralimital in the Western Behm Canal. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-25 and Table 3.4-26). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Eastern North Pacific stock (Table 3.4-26).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of gray whales incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 2 may affect ESA-listed gray whales.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-25: Gray Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-26: Estimated Impacts on Individual Gray Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Eastern North Pacific	2	0	0	32	19	0
Western North Pacific	0	0	0	0	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Odontocetes

Odontocetes may be exposed to sound from sonar and other transducers associated with training and testing activities throughout the year. Low- (less than 1 kHz), mid- (1–10 kHz), high-frequency (10–100 kHz), and very high-frequency (100–200 kHz) sonars produce sounds that are likely to be within the audible range of odontocetes (see Section 3.4.1.6, Hearing and Vocalization). If a sound is within an animal's hearing range then behavioral reactions, physiological stress, masking and hearing loss are potential impacts that must be analyzed. If a marine mammal cannot hear a sound, then behavioral reactions, physiological stress, masking, or hearing loss could not occur. Impact ranges for odontocetes are discussed under mid-frequency cetaceans in Section 3.4.2.1.2 (Impacts from Sonar and Other Transducers).

Behavioral reactions in odontocetes (except beaked whales and harbor porpoise) resulting from exposure to sonar could take place at distances of up to 20 km. Beaked whales and harbor porpoise have demonstrated a high level of sensitivity to human-made noise and activity; therefore, the quantitative analysis assumes that some harbor porpoises and some beaked whales could experience significant behavioral reactions at a distance of up to 50 km from the sound source. Behavioral reactions, however, are much more likely within a few kilometers of the sound source for most species of odontocetes such as delphinids and sperm whales. Even for harbor porpoise and beaked whales, as discussed above in *Assessing the Severity of Behavioral Responses from Sonar*, the quantitative analysis has very likely overestimated the numbers of behavioral reactions due to the underlying nature of the data used to derive the behavioral response functions.

Research shows that if odontocetes do respond they may react in a number of ways, depending on the characteristics of the sound source and their experience with the sound source. Behavioral reactions may include alerting; breaking off feeding dives and surfacing; or diving or swimming away. Animals disturbed while engaged in other activities such as feeding or reproductive behaviors may be more likely to ignore or tolerate the disturbance and continue their natural behavior patterns. Therefore, most behavioral reactions from odontocetes are likely to be short-term and low to moderate severity.

Large odontocetes such as killer whales and pilot whales have been the subject of behavioral response studies (see Section 3.4.2.1.1.5, Behavioral Reactions). Based on these studies, a number of reactions could occur such as a short-term cessation of natural behavior such as feeding, avoidance of the sound source, or even attraction towards the sound source as seen in pilot whales. Due to the factors involved in Navy training and testing exercises versus the conditions under which pilot whales and killer whales were exposed during behavioral response studies, large odontocetes are unlikely to have more than short-term and moderate severity reactions to sounds from sonar or other human disturbance, and typically only at ranges within a few kilometers. Most estimated impacts are due to anti-submarine warfare activities, which could vary in duration and intensity. Anti-submarine warfare unit-level exercises and maintenance typically last for a matter of a few hours and involves a limited amount of sonar use so significant responses would be less likely than with longer and more intense exercises (more sonar systems and vessels). Coordinated/integrated anti-submarine warfare exercises involve multiple sonar systems and can last for a period of days, making significant response more likely. A single or few short-lived TTS or behavioral reactions per year are unlikely to have any significant costs or long-term consequences for individuals.

Small odontocetes have been the subject of behavioral response studies and observations in the field (see Section 3.4.2.1.1.5, Behavioral Reactions). Based on these studies, small odontocetes (dolphins) appear to be less sensitive to sound and human disturbance than other cetacean species. If reactions did occur, they could consist of a short-term behavior response such as cessation of feeding, avoidance of the sound source, or even attraction towards the sound source. Small odontocetes are unlikely to have more than short-term and moderate severity reactions to sounds from sonar or other human disturbance, and typically only at ranges within a few kilometers. Most estimated impacts are due to anti-submarine warfare activities, which could vary in duration and intensity. Anti-submarine warfare unit-level exercises and maintenance typically last for a matter of a few hours and involve a limited amount of sonar use so significant responses would be less likely than with longer and more intense exercises (more sonar systems and vessels). Coordinated/integrated anti-submarine warfare exercises involve multiple sonar systems and can last for a period of days, making significant response more likely. Some bottlenose dolphin estimated impacts could also occur due to navigation and object avoidance (detection) since these activities typically occur entering and leaving Navy homeports that overlap the distribution of coastal populations of this species. Navigation and object avoidance (detection) activities normally involve a single ship or submarine using a limited amount of sonar; therefore, significant reactions are unlikely. A single or few short-lived TTS or behavioral reactions per year are unlikely to have any significant costs or long-term consequences for individuals.

Some odontocetes may avoid larger activities such as a major training exercise as it moves through an area. Vessels and aircraft associated with training or testing activities are typically in transit during an event (they are not stationary) and activities typically do not use the same training locations day-after-day during multi-day activities. If an event otherwise focuses on a fixed location, sensitive species of odontocetes, such as beaked whales, may avoid the location of the activity for the duration of the event. Section 3.4.2.1.1.5 (Behavioral Reactions) discusses these species' observed reactions to sonar and other transducers. If animals are displaced, they would likely return after the sonar activity subsides within an area, as seen in Blainville's beaked whales in the Bahamas (Tyack et al., 2011) and Hawaii (Henderson et al., 2015; Henderson et al., 2016; Manzano-Roth et al., 2016). This would allow the animal to recover from any energy expenditure or missed resources, reducing the likelihood of long-term consequences for the individual. It is unlikely that most individuals would encounter a major training exercise more than once per year due to where these activities are typically conducted. Outside of Navy instrumented ranges and homeports, the use of sonar and other transducers is transient and is unlikely to expose the same population of animals repeatedly over a short period. However, a few behavioral reactions per year from a single individual are unlikely to produce long-term consequences for that individual.

Behavioral research indicates that most odontocetes avoid sound sources at levels that would cause any temporary hearing loss (i.e., TTS) (see Section 3.4.2.1.1.5, Behavioral Reactions). TTS and even PTS is more likely for high-frequency cetaceans, such as harbor porpoises and Kogia whales, because hearing loss thresholds for these animals are lower than for all other marine mammals. These species, especially harbor porpoises, have demonstrated a high level of sensitivity to human-made sound and activities and may avoid at further distances. This increased distance could avoid or minimize hearing loss for these species as well, especially as compared to the estimates from the quantitative analysis. Therefore, it is likely that the quantitative analysis overestimates TTS and PTS in marine mammals because it does not account for animals avoiding sound sources at closer ranges. Recovery from hearing loss begins almost immediately after the noise exposure ceases and can take a few minutes to a few days to fully recover, depending on the magnitude of the initial TS. TTS would be recoverable and PTS would leave some residual hearing loss. Most TTS, if it does actually occur, would be more likely to be minor to moderate (i.e., less than 20 dB of TTS directly after the exposure) and would recover within a matter of minutes to hours. Threshold shifts do not necessarily affect all hearing frequencies equally, and typically manifest themselves at the exposure frequency or within an octave above the exposure frequency. During the period that an odontocete had hearing loss, social calls from conspecifics could be more difficult to detect or interpret. Killer whales are a primary predator of odontocetes. Some hearing loss could make killer whale calls more difficult to detect at further ranges until hearing recovers. Odontocetes use echolocation clicks to find and capture prey. These echolocation clicks and vocalizations are at frequencies above a few tens of kHz for delphinids, beaked whales, and sperm whales, and above 100 kHz for porpoises and Kogia whales. Echolocation associated with feeding and navigation in odontocetes is unlikely to be affected by TS at lower frequencies and should not have any significant effect on an odontocete’s ability to locate prey or navigate, even in the short term. Therefore, a single or even a few minor TTS (less than 20 dB of TTS) to an individual odontocete per year are unlikely to have any long-term consequences for that individual. Minor PTS (a few dB or less) in an individual could have no to minor long-term consequences for individuals.

Research and observations of masking in marine mammals are discussed in Section 3.4.2.1.1.4 (Masking). Many anti-submarine warfare sonars and countermeasures use low- and mid-frequency sonar. Most low- and mid-frequency sonar signals (i.e., sounds) are limited in their temporal, frequency, and spatial domains. The duration of most individual sounds is short, lasting up to a few seconds each. Some systems operate with higher duty cycles or nearly continuously, but typically use lower power. Nevertheless, masking may be more prevalent at closer ranges to these high-duty cycle and continuous active sonar systems. Most anti-submarine warfare activities are geographically dispersed and last for only a few hours, often with intermittent sonar use even within this period. Most anti-submarine warfare sonars also have a narrow frequency band (typically much less than one-third octave). These factors reduce the likelihood of sources causing significant masking in odontocetes due to exposure to sonar used during anti-submarine warfare activities. Odontocetes may experience some limited masking at closer ranges from high-frequency sonars and other transducers; however, the frequency band of the sonar is narrow, limiting the likelihood of masking. High-frequency sonars are typically used for mine hunting, navigation, and object detection (avoidance). Potential costs to odontocetes from masking are similar to those discussed above for mild to moderate levels of TTS, with the primary difference being that the effects of masking are only present when the sound source (i.e., sonar) is actively pinging and the effect is over the moment the sound has ceased.

Nevertheless, odontocetes that do experience some masking from sonar or other transducers may have their ability to communicate with conspecifics reduced, especially at further ranges. Sounds from mid-frequency sonar could mask killer whale vocalizations making them more difficult to detect, especially at further ranges. As discussed above for TTS, odontocetes use echolocation to find prey and navigate. The echolocation clicks of odontocetes are above the frequencies of most sonar systems, especially those used during anti-submarine warfare. Therefore, echolocation associated with feeding and navigation in odontocetes is unlikely to be masked by sounds from sonars or other transducers. A single or even a few short periods of masking, if it were to occur, to an individual odontocete per year are unlikely to have any long-term consequences for that individual.

Common Bottlenose Dolphins

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Common bottlenose dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions under Alternative 1 (Figure 3.4-26 and Table 3.4-27). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-27).

As described for odontocetes above, even a few minor to moderate behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of common bottlenose dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Common bottlenose dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions under Alternative 1 (Figure 3.4-26 and Table 3.4-27). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-27).

As described for odontocetes above, even a few minor to moderate behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of common bottlenose dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-26: Common Bottlenose Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-27: Estimated Impacts on Individual Common Bottlenose Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	5	0	0	3	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Common bottlenose dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions under Alternative 2 (Figure 3.4-27 and Table 3.4-28). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-28).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of common bottlenose dolphins incidental to those activities.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Common bottlenose dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions under Alternative 2 (Figure 3.4-27 and Table 3.4-28). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-28).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of common bottlenose dolphins incidental to those activities.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-27: Common Bottlenose Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-28: Estimated Impacts on Individual Common Bottlenose Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	5	0	0	5	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Killer Whales (one DPS is Endangered Species Act-Listed)

For the populations of killer whales present in the Study Area, only the Southern Resident population is listed as endangered under the ESA. Southern Resident killer whales have designated critical habitat in the Inland Waters portion of the Study Area and proposed critical habitat in the NWTT Offshore Area.

In addition to procedural mitigation, the Navy developed the following mitigation areas to avoid or reduce potential impacts from sonar and other transducers on killer whales in their important feeding and migration habitats, as described in Appendix K (Geographic Mitigation Assessment):

- **Marine Species Coastal Mitigation Area.** The Marine Species Coastal Mitigation Area overlaps important Southern Resident whale migration and feeding areas, including proposed critical habitat, in the NWTT Offshore Area. Within 50 NM from shore in this mitigation area, the Navy will issue annual seasonal awareness notification messages to alert ships and aircraft to the possible presence of increased concentrations of Southern Resident killer whales. For safe navigation and to avoid interactions with large whales, the Navy will instruct vessels to remain vigilant to the presence of Southern Resident killer whales that may be vulnerable to potential impacts from training and testing activities. Platforms will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation. Within 12 NM from shore in this mitigation area, the Navy will not conduct Anti-Submarine Warfare Tracking Exercise – Helicopter, – Maritime Patrol Aircraft, – Ship, or – Submarine training activities (which involve the use of mid-frequency or high-frequency active sonar), or non-explosive Anti-Submarine Warfare Torpedo Exercise – Submarine training activities (which also involve the use of mid-frequency or high-frequency active sonar). The Navy will conduct a maximum of one Unmanned Underwater Vehicle Training event within 12 NM from shore at the Quinault Range Site. Unmanned Underwater Vehicle Training events within 12 NM from shore at the Quinault Range Site will be cancelled or moved to another training location if Southern Resident killer whales are detected at the planned training location during the event planning process, or immediately prior to the event, as applicable.
- **Olympic Coast National Marine Sanctuary Mitigation Area.** The Olympic Coast National Marine Sanctuary Mitigation Area overlaps important Southern Resident killer whale migration and feeding habitats, including proposed critical habitat, in the NWTT Offshore Area. Within this mitigation area, the Navy will conduct a maximum of 32 hours of surface ship hull-mounted MF1 mid-frequency active sonar during training annually.

- **Olympic Coast National Marine Sanctuary Mitigation Area, Juan de Fuca Eddy Marine Species Mitigation Area, and 20 NM From Shore in the Marine Species Coastal Mitigation Area.** The Juan de Fuca Eddy Marine Species Mitigation Area overlaps important Southern Resident killer whale migration habitat off Cape Flattery. The important habitats that overlap the other mitigation areas are identified in bullets above. Within these combined mitigation areas, the Navy will conduct a maximum combined total of 33 hours of surface ship hull-mounted MF1 mid-frequency active sonar during testing annually.
- **Puget Sound and Strait of Juan de Fuca Mitigation Area.** The Puget Sound and Strait of Juan de Fuca Mitigation Area encompasses all NWTT Inland Waters and overlaps Southern Resident killer whale critical habitat in that portion of the Study Area. Within this mitigation area, the Navy will implement the following mitigation measures for active sonar activities that are likely to avoid or reduce potential impacts on Southern Resident killer whales:
    - The Navy will not use low-frequency, mid-frequency, or high-frequency active sonar during training or testing within the Puget Sound and Strait of Juan de Fuca Mitigation Area, unless a required element necessitates that the activity be conducted in NWTT Inland Waters during (1) Unmanned Underwater Vehicle Training, (2) Civilian Port Defense – Homeland Security Anti-Terrorism/Force Protection Exercises, (3) activities conducted at designated Naval Sea Systems Command testing sites, and (4) pierside sonar maintenance or testing at designated locations.
    - The Navy will use the lowest active sonar source levels practical to successfully accomplish each event.
    - Naval units will obtain permission from the appropriate designated Command authority prior to commencing pierside maintenance or testing with hull-mounted mid-frequency active sonar.
    - The Navy will conduct a maximum of one Unmanned Underwater Vehicle Training activity annually at the Navy 3 Operating Area (OPAREA) and Manchester Fuel Depot (i.e., a maximum of one event at each location), which are the two activity locations associated with the highest potential Southern Resident killer whale densities.
    - Navy event planners will coordinate with Navy biologists during the event planning process prior to Unmanned Underwater Vehicle Training at the NAVY 3 OPAREA, Manchester Fuel Depot, Crescent Harbor Explosive Ordnance Disposal Range, and NAVY 7 OPAREA; and prior to Civilian Port Defense – Homeland Security Anti-Terrorism/Force Protection Exercises (which involve the use of high-frequency active sonar). Navy biologists will work with NMFS and will initiate communication with the appropriate marine mammal detection networks to determine the likelihood of Southern Resident killer whale presence in the planned training location. To the maximum extent practicable, Navy planners will use this information when planning specific details of the event (e.g., timing, location, duration) to avoid planning activities in locations or seasons where Southern Resident killer whale presence is expected. The Navy will ensure environmental awareness of event participants. Environmental awareness will help alert participating crews to the possible presence of applicable species in the training location. Lookouts will use the information to assist visual observation of applicable mitigation zones and to aid in the implementation of procedural mitigation. Unmanned Underwater Vehicle Training events at the NAVY 3 OPAREA, Manchester Fuel Depot,

Crescent Harbor Explosive Ordnance Disposal Range, and NAVY 7 OPAREA will be cancelled or moved to another training location if the presence of Southern Resident killer whales is reported through available monitoring networks during the event planning process, or immediately prior to the event, as applicable.

- o The Navy will issue annual seasonal awareness notification messages to alert ships and aircraft operating within the Puget Sound and Strait of Juan de Fuca Mitigation Area to the possible presence of seasonal concentrations of Southern Resident killer whales. For safe navigation and to avoid interactions with large whales, the Navy will instruct vessels to remain vigilant to the presence of Southern Resident killer whales that may be vulnerable to vessel strikes or potential impacts from training and testing activities. Platforms will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation.

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Killer whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-28 and Table 3.4-29). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-29).

As described for odontocetes above, a few minor to moderate TTS or behavioral reactions experienced by an individual over the course of a year are unlikely to have significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Sound from sonars and other transducers during training activities would overlap designated critical habitat in the Inland Waters and proposed critical habitat in the Offshore Area. As described in Section 3.4.1.16, essential features for the conservation of the Southern Resident DPS designated and proposed critical habitat include (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging. None of these essential features would be adversely affected by sonar use proposed in this action, as follows:

- Sonars used during training would not have a plausible route to affect the physical nature of water quality as defined under critical habitat.
- Southern Resident killer whales prey primarily on Chinook salmon in the Inland Waters portion of the NWTT Study Area during a subset of the year (summer/spring), in addition to other salmonids and fish species. The prey preferences of Southern Resident killer whales in the Offshore Area and during other times of the year are less understood, but is known to include halibut, herring, sardine, rockfish, sablefish, lingcod, and dover sole (Ford et al., 2017; Ford et al., 2009b; Ford et al., 2016; Hanson et al., 2010). The portion of these other prey items that make up their diet throughout the year is currently unknown and likely correlated with migration timing of different salmonid populations (National Marine Fisheries Service, 2019f). As described in Section 5.5.1.1.2.2 (Injury due to Sonar and Other Transducers) of the Fishes

section, non-impulsive sound sources, such as sonar and other transducers, have not been known to cause direct injury or mortality to fish under conditions that would be found in the wild (Halvorsen et al., 2012; Kane et al., 2010; Popper et al., 2007). Training activities that use sonar and other transducers with frequency content at or below 2 kHz in the hearing range of salmonids would not be used in the Inland Waters; therefore, fishes that occur in the Inland Waters would not be exposed to these sources. The few sources used within salmonid and other prey species hearing range would be limited and typically transient, as shown in Appendix A (Navy Activities Descriptions) and examined in Section 3.9.3.1.2 (Impacts from Sonar and Other Transducers) of the Fishes section. The use of sonar and other transducers in the Offshore Area would likely only result in brief behavioral responses and would not reduce the overall quality, quantity or abundance of available prey items within the proposed critical habitat. Additionally, this proposed use of sonars would not chronically elevate background noise causing a reduction in foraging space in critical habitat for Southern Resident killer whales. Brief periods of masking due to spatially and temporally isolated exposures are assumed to be accounted for in the quantitative assessment of the potential for direct behavioral disturbance as a level-based response as explained in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017b).

- Use of sonars would be transient or temporary during training activities, and thus would not obstruct waterways or create a barrier. Additionally, the mitigation areas described above would limit the use of the most powerful sonar sources throughout designated critical habitat. The potential for killer whales of the Southern Resident DPS to respond to sonar sources, including the potential for avoidance responses, is assessed in the quantitative analysis of effects described above.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of killer whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 1 may affect ESA-listed killer whales. The Navy has consulted with NMFS as required by Section 7(a)(2). The use of sonar and other transducers during training activities would have no effect on designated critical habitat for the Southern Resident DPS of killer whale in the Inland Waters or on proposed critical habitat for the Southern Resident DPS of killer whale in the Offshore Area.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Killer whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-28 and Table 3.4-29). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-29).

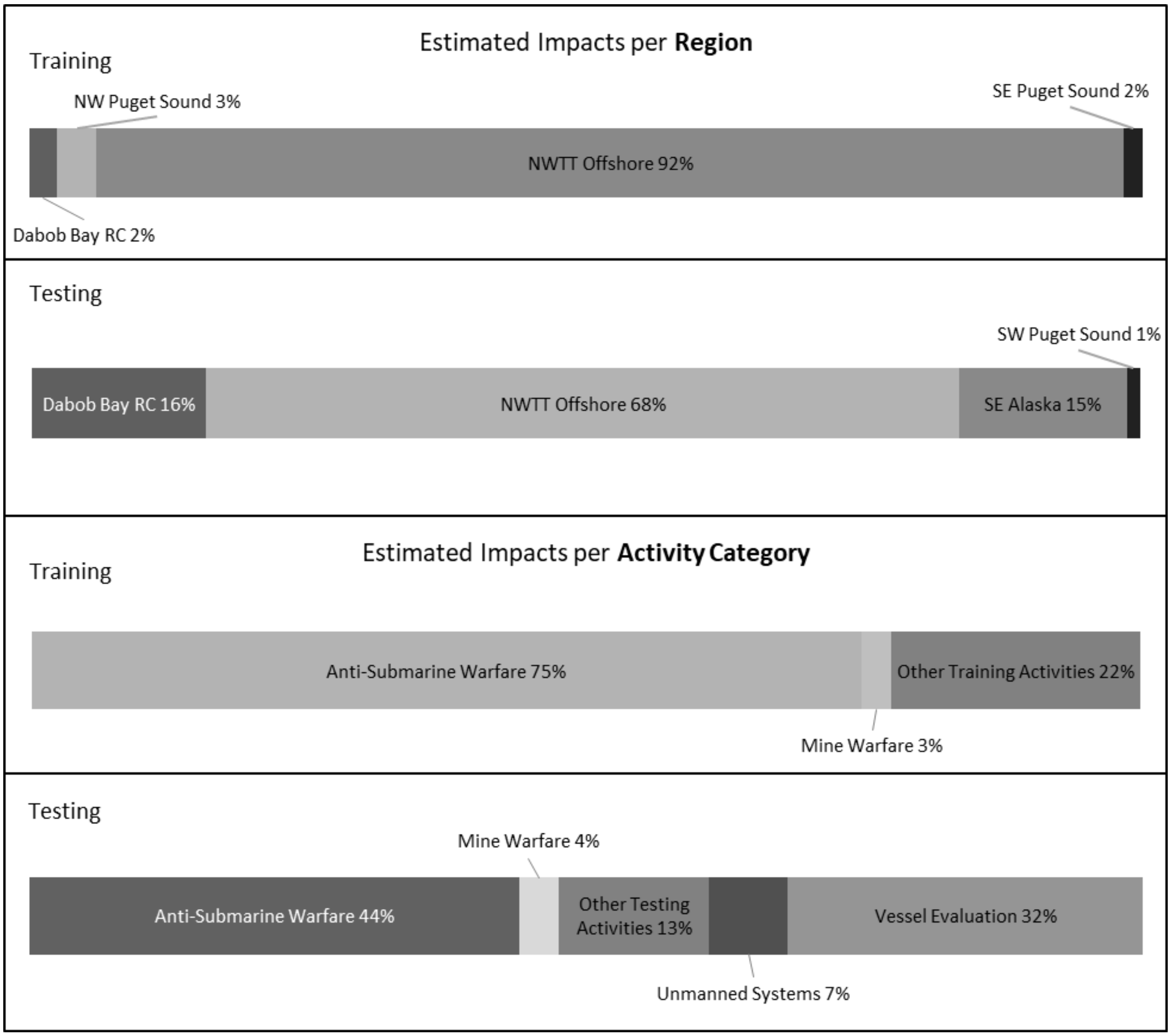
As described for odontocetes above, a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Sound from sonars and other transducers during testing activities would overlap designated critical habitat in the Inland Waters and proposed critical habitat in the Offshore Area. As described in Section 3.4.1.16, essential features for the conservation of designated and proposed critical habitat include (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging. None of these essential features would be adversely affected by sonar use proposed in this action, as follows:

- Sonars used during testing would not have a plausible route to affect the physical nature of water quality as defined under critical habitat.
- Southern Resident killer whales prey primarily on Chinook salmon in the Inland Waters portion of the NWTT Study Area during a subset of the year (summer/spring), in addition to other salmonids and fish species. The prey preferences of Southern Resident killer whales in the Offshore Area and during other times of the year are less understood, but are known to include halibut, herring, sardine, rockfish, sablefish, lingcod, and dover sole (Ford et al., 2017; Ford et al., 2009b; Ford et al., 2016; Hanson et al., 2010). The portion of these other prey items that make up their diet throughout the year is currently unknown and likely correlated with migration timing of different salmonid populations (National Marine Fisheries Service, 2019f). As described in Section 5.5.1.1.2.2 (Injury due to Sonar and Other Transducers) of the Fishes section, non-impulsive sound sources, such as sonar and other transducers, have not been known to cause direct injury or mortality to fish under conditions that would be found in the wild (Halvorsen et al., 2012; Kane et al., 2010; Popper et al., 2007). Most sources proposed for use during testing activities overlapping or adjacent to critical habitat in the Study Area would not fall within the frequency range of salmonid hearing, thereby presenting no plausible route of effect on salmonids. The few sources used within salmonid hearing range would be limited and typically transient, as shown in Appendix A (Navy Activities Descriptions) and examined in Section 3.9.3.1.2 (Impacts from Sonar and Other Transducers) of the Fishes section. The use of sonar and other transducers in the Offshore Area would likely only result in brief behavioral responses and would not reduce the overall quality, quantity, or abundance of available prey items within the proposed critical habitat. Additionally, this proposed use of sonars would not chronically elevate background noise causing a reduction in foraging space in critical habitat for Southern Resident killer whales. Brief periods of masking due to spatially and temporally isolated exposures are accounted for in the quantitative assessment of the potential for direct behavioral disturbance as a level-based response as explained in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017b).
- Use of sonars would be transient or temporary during testing activities, and thus would not obstruct waterways or create a barrier. Additionally, the mitigation areas described above would limit the use of the most powerful sonar sources throughout designated critical habitat. The potential for killer whales of the Southern Resident DPS to respond to sonar sources, including the potential for avoidance responses, is assessed in the quantitative analysis of effects described above.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of killer whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 1 may affect ESA-listed killer whales and proposed critical habitat for the Southern Resident DPS of killer whale in the Offshore Area. The Navy has consulted with NMFS as required by Section 7(a)(2). The use of sonar and other transducers during testing activities would have no effect on designated critical habitat for the Southern Resident DPS of killer whale in the Inland Waters or on proposed critical habitat for the Southern Resident DPS of killer whale in the Offshore Area.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-28: Killer Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-29: Estimated Impacts on Individual Killer Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Alaska Resident	0	0	0	34	0	0
Eastern North Pacific Offshore	67	1	0	85	4	0
Northern Resident	0	0	0	0	0	0
West Coast Transient	76	2	0	134	20	0
Southern Resident	3	0	0	46	2	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Killer whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-29 and Table 3.4-30). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-30).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of killer whales incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 2 may affect ESA-listed killer whales. The use of sonar and other transducers during training activities would have no effect on designated critical habitat for the Southern Resident DPS of killer whale in the Inland Waters or on proposed critical habitat for the Southern Resident DPS of killer whale in the Offshore Area.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Killer whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-29 and Table 3.4-30). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-30).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although potential for of impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of killer whales incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 2 may affect ESA-listed killer whales. The use of sonar and other transducers during testing activities would have no effect on designated critical habitat for the Southern Resident DPS of killer whale in the Inland Waters or on proposed critical habitat for the Southern Resident DPS of killer whale in the Offshore Area.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-29: Killer Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-30: Estimated Impacts on Individual Killer Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Alaska Resident	0	0	0	40	0	0
Eastern North Pacific Offshore	69	1	0	111	4	0
Northern Resident	0	0	0	0	0	0
West Coast Transient	79	2	0	166	22	0
Southern Resident	3	0	0	60	2	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Northern Right Whale Dolphins

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Northern right whale dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-30 and Table 3.4-31). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-31).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of Northern right whale dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

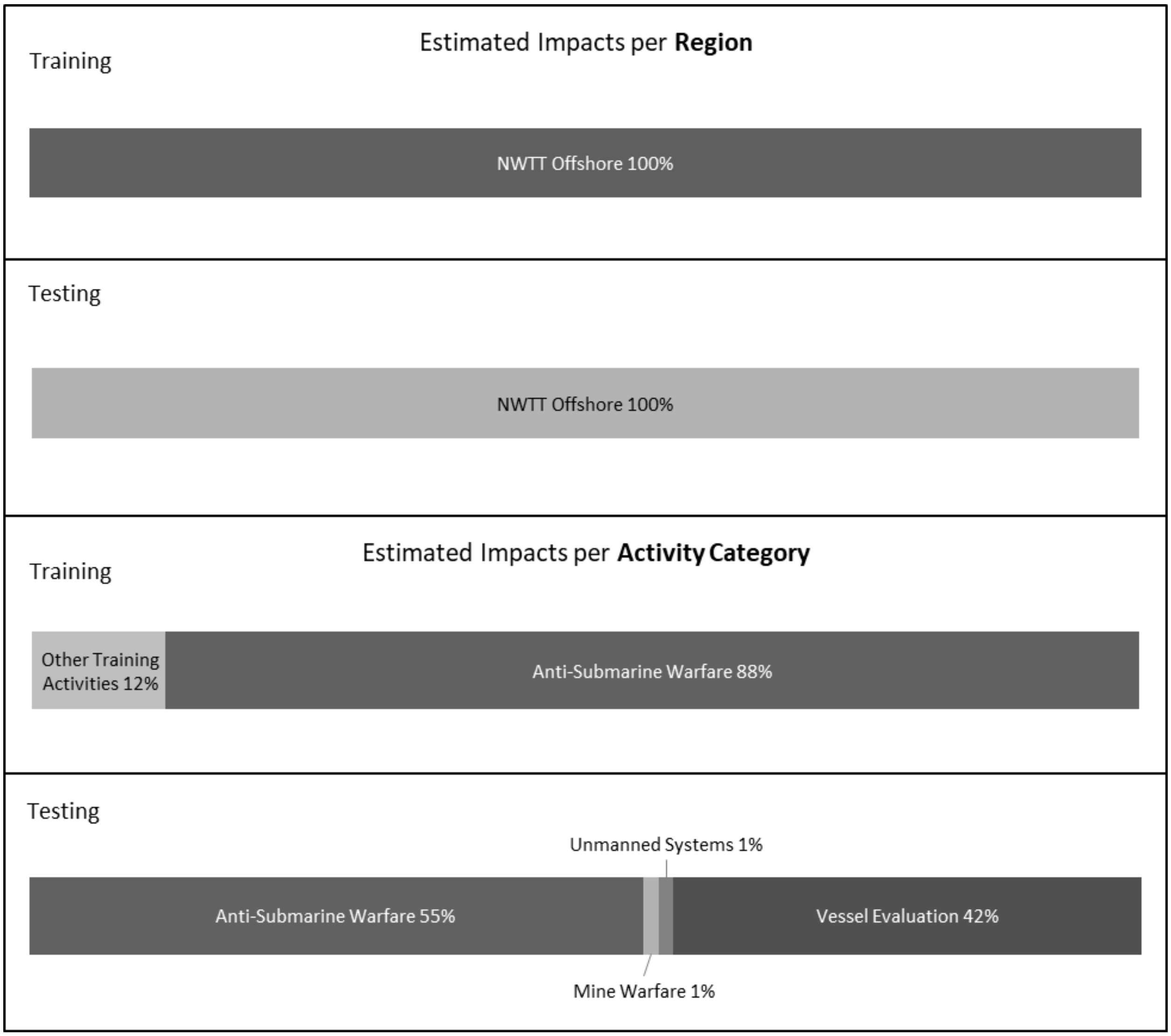
Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Northern right whale dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under Alternative 1 (Figure 3.4-30 and Table 3.4-31). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-31).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences

for that individual. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial TS. Minor PTS (a few dB or less) in an individual could have no to minor long-term consequences for individuals. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of Northern right whale dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-30: Northern Right Whale Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-31: Estimated Impacts on Individual Northern Right Whale Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	7,785	156	0	12,885	872	1

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Northern right whale dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-31 and Table 3.4-32). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-32).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of Northern right whale dolphins incidental to those activities.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Northern right whale dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under Alternative 2 (Figure 3.4-31 and Table 3.4-32). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-32).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of northern right whale dolphins incidental to those activities.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-31: Northern Right Whale Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-32: Estimated Impacts on Individual Northern Right Whale Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	7,985	156	0	16,742	975	1

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Pacific White-Sided Dolphins

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Pacific white-sided dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-32 and Table 3.4-33). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-33).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

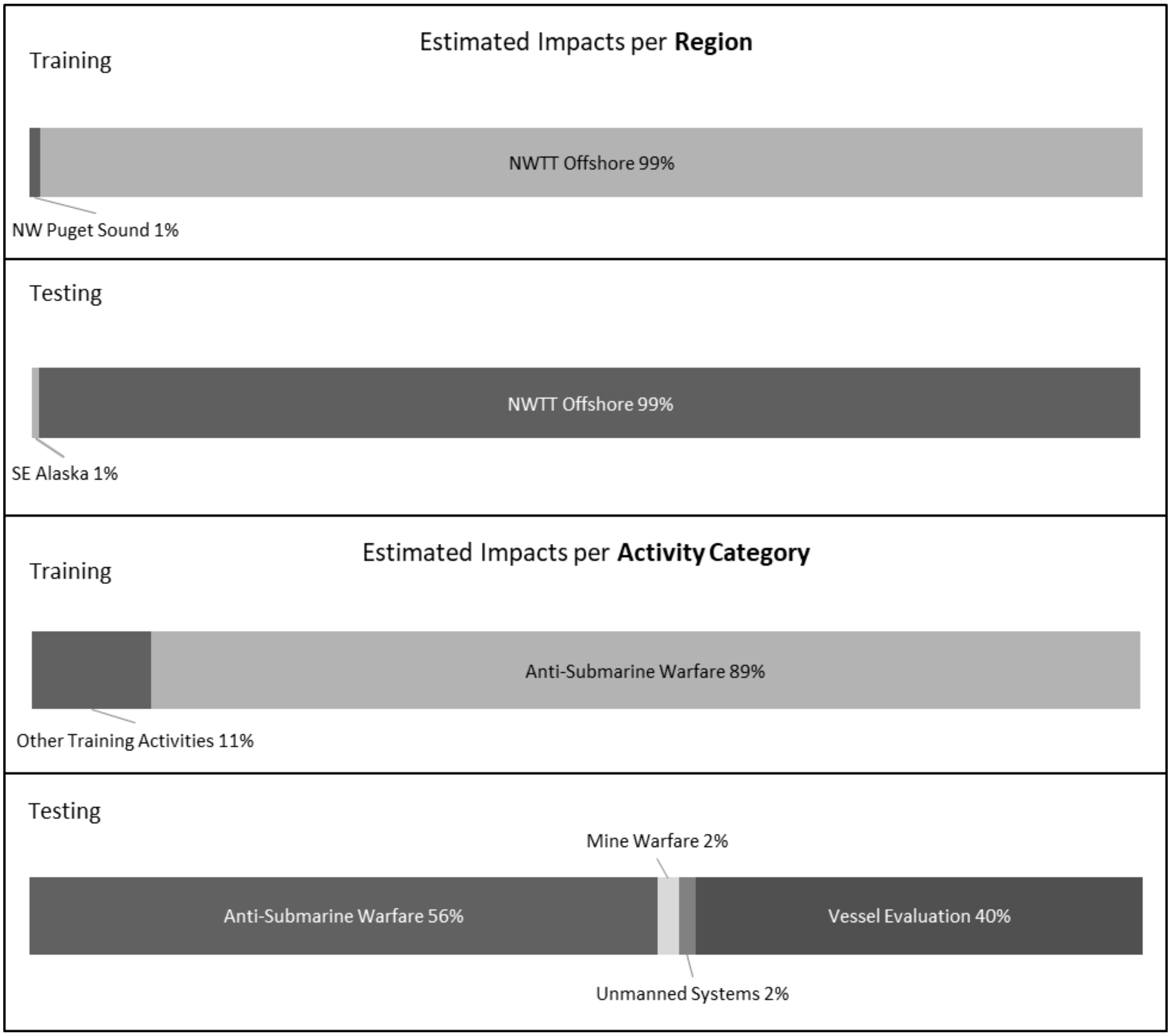
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of Pacific white-sided dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Pacific white-sided dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under Alternative 1 (Figure 3.4-32 and Table 3.4-33). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-33).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial TS. Minor PTS (a few dB or less) in an individual could have no to minor long-term consequences for individuals. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of Pacific white-sided dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-32: Pacific White-Sided Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-33: Estimated Impacts on Individual Pacific White-Sided Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
North Pacific	0	0	0	101	0	0
California, Oregon, & Washington	5,198	86	0	14,394	1,285	1

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Pacific white-sided dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-33 and Table 3.4-34). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-34).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of Pacific white-sided dolphins incidental to those activities.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Pacific white-sided dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under Alternative 2 (Figure 3.4-33 and Table 3.4-34). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-34).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of Pacific white-sided dolphins incidental to those activities.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-33: Pacific White-Sided Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-34: Estimated Impacts on Individual Pacific White-Sided Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
North Pacific	0	0	0	117	0	0
California, Oregon, & Washington	5,311	87	0	18,674	1,421	1

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Risso's Dolphins

<u>Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities</u>

Risso's dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-34 and Table 3.4-35). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-35).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

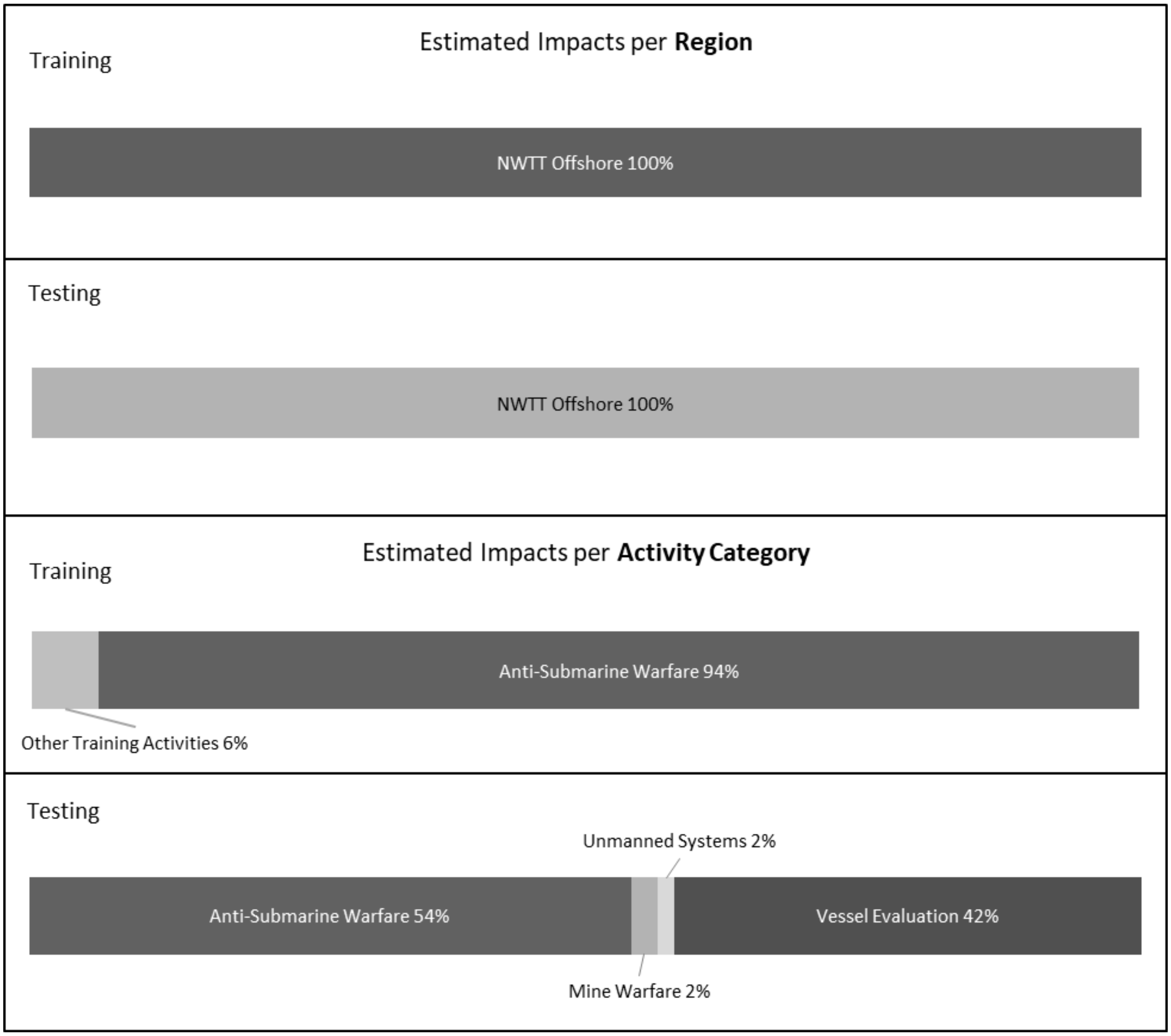
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of Risso's dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

<u>Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities</u>

Risso's dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-34 and Table 3.4-35). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-35).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of Risso's dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-34: Risso's Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-35: Estimated Impacts on Individual Risso's Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	2,240	46	0	3,840	228	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Risso's dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-35 and Table 3.4-36). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-36).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

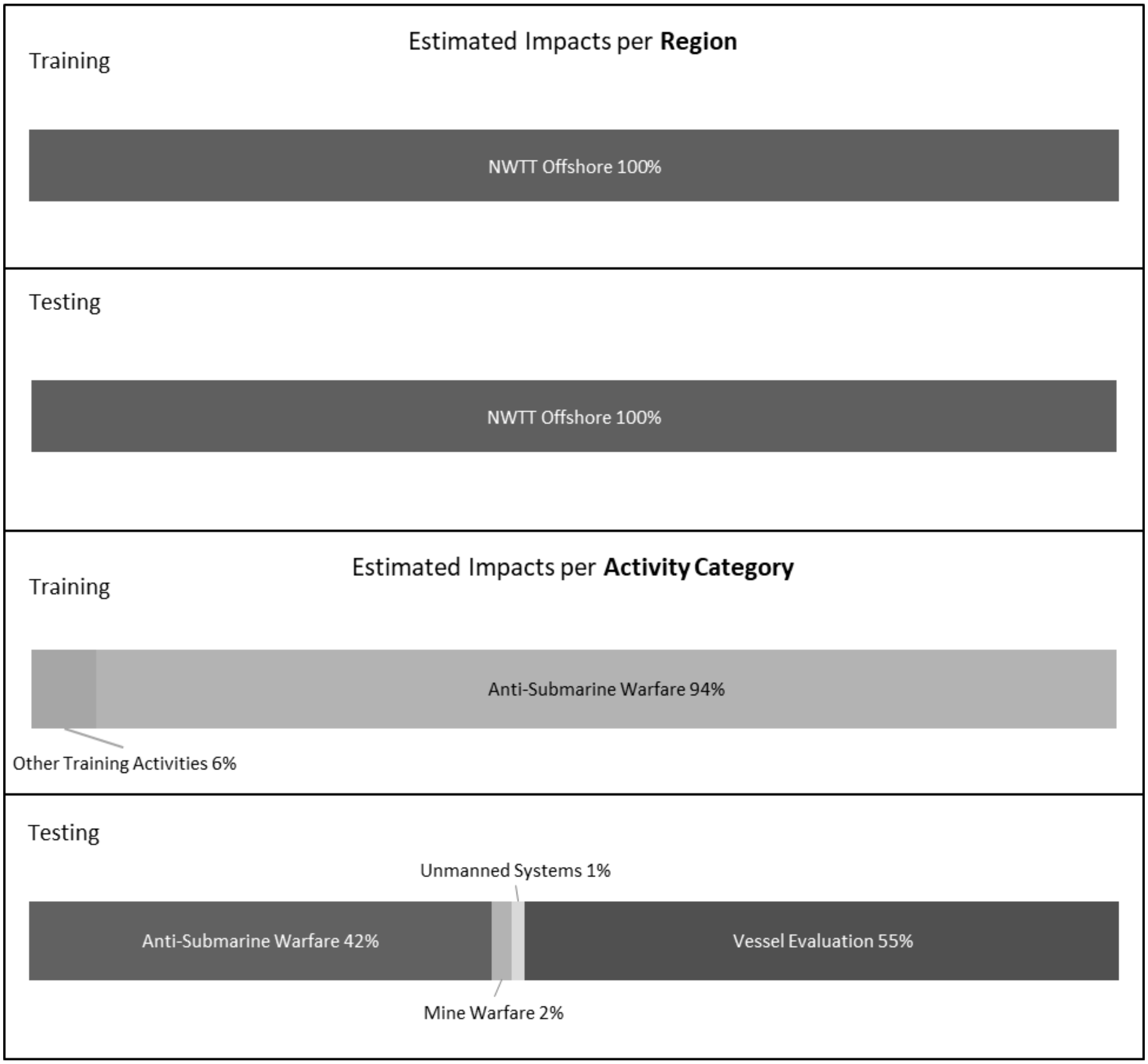
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of Risso's dolphins incidental to those activities.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Risso's dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-35 and Table 3.4-36). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-36).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of Risso's dolphins incidental to those activities.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-35: Risso's Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-36: Estimated Impacts on Individual Risso's Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	*Training*			*Testing*		
	Behavioral	*TTS*	*PTS*	*Behavioral*	*TTS*	*PTS*
California, Oregon, & Washington	2,301	46	0	4,994	260	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Short-Beaked Common Dolphin

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Short-beaked common dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. Under The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-36 and Table 3.4-37). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-37).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

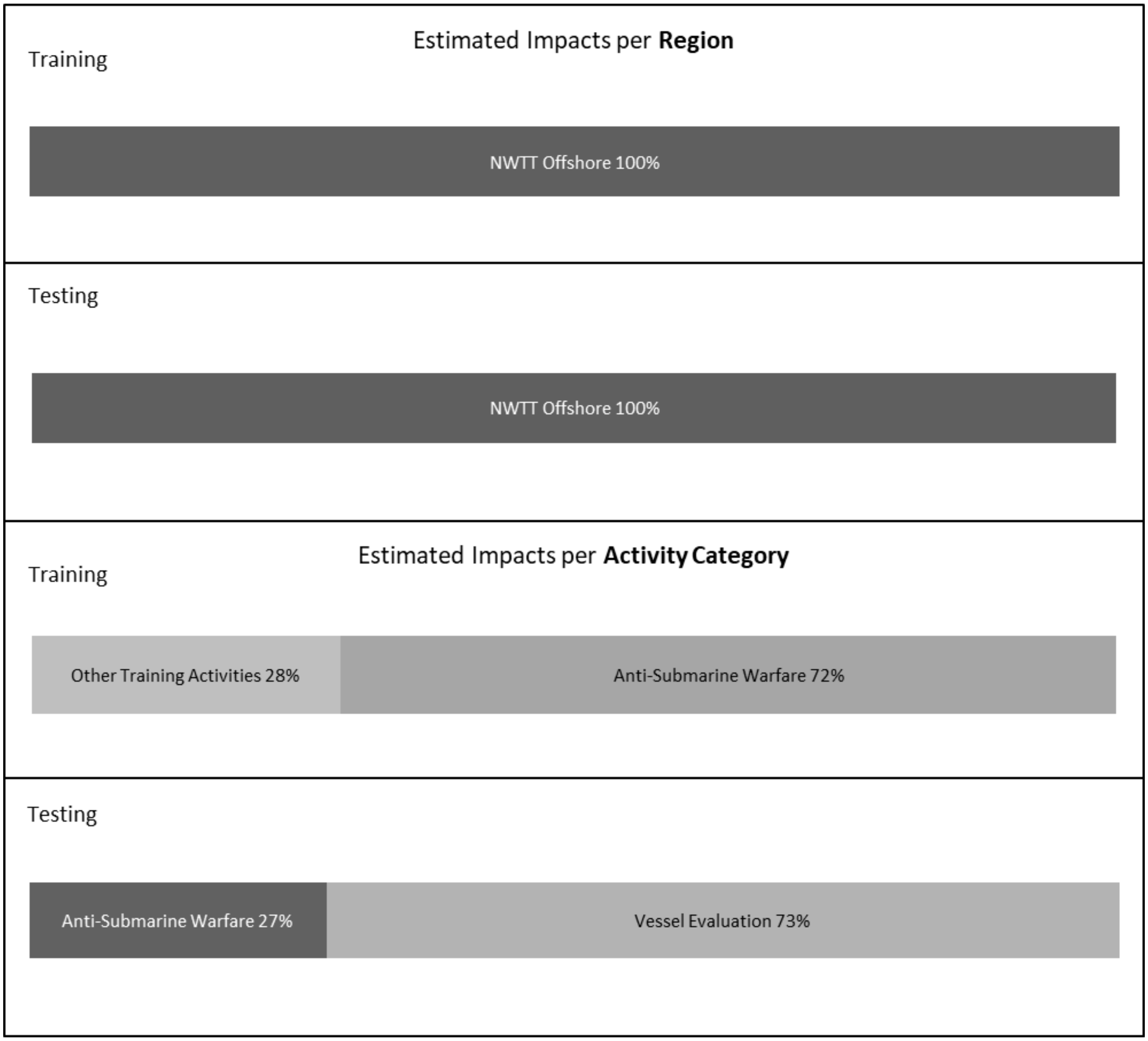
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of short-beaked common dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Short-beaked common dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-36 and Table 3.4-37). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-37).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of short-beaked common dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-36: Short-Beaked Common Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-37: Estimated Impacts on Individual Short-Beaked Common Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	1,140	25	0	963	21	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Short-beaked common dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-37 and Table 3.4-38). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-38).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

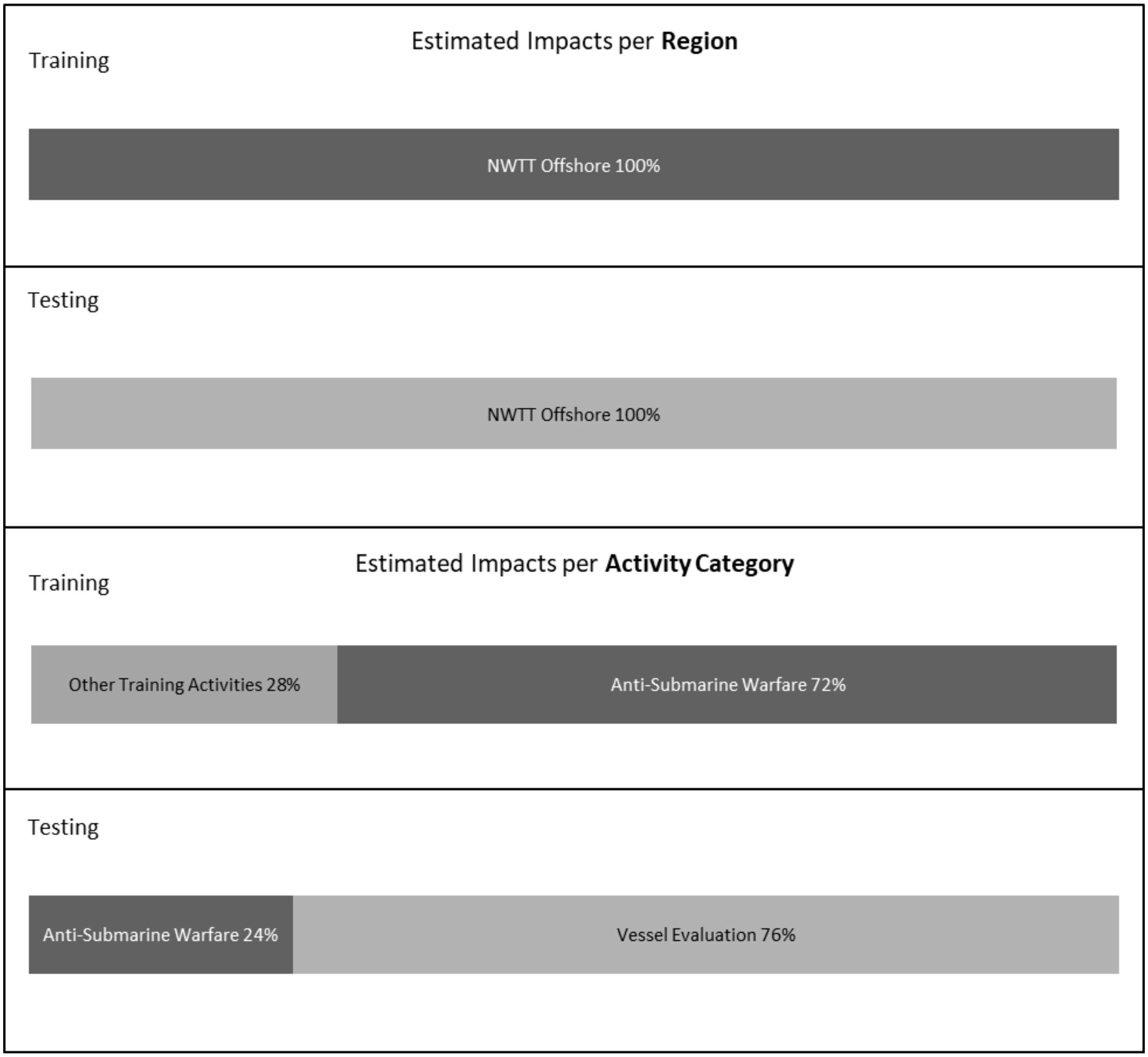
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of short-beaked common dolphins incidental to those activities.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Short-beaked common dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-37 and Table 3.4-38). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-38).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of short-beaked common dolphins incidental to those activities.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-37: Short-Beaked Common Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-38: Estimated Impacts on Individual Short-Beaked Common Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Stock	Training			Testing		
	Behavioral	*TTS*	*PTS*	*Behavioral*	*TTS*	*PTS*
California, Oregon, & Washington	1,152	25	0	1,316	24	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Short-Finned Pilot Whales

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Short-finned pilot whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions under Alternative 1 (Figure 3.4-38 and Table 3.4-39). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-39).

As described for odontocetes above, even a few minor to moderate behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of short-finned pilot whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Short-finned pilot whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-38 and Table 3.4-39). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-39).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of short-finned pilot whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-38: Short-Finned Pilot Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-39: Estimated Impacts on Individual Short-Finned Pilot Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	57	0	0	30	1	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Short-finned pilot whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions under Alternative 2 (Figure 3.4-39 and Table 3.4-40). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-40).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of short-finned pilot whales incidental to those activities.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Short-finned pilot whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-39 and Table 3.4-40). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-40).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of short-finned pilot whales incidental to those activities.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-39: Short-Finned Pilot Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-40: Estimated Impacts on Individual Short-Finned Pilot Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	58	0	0	40	1	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Striped Dolphins

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Striped dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-40 and Table 3.4-41). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-41).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

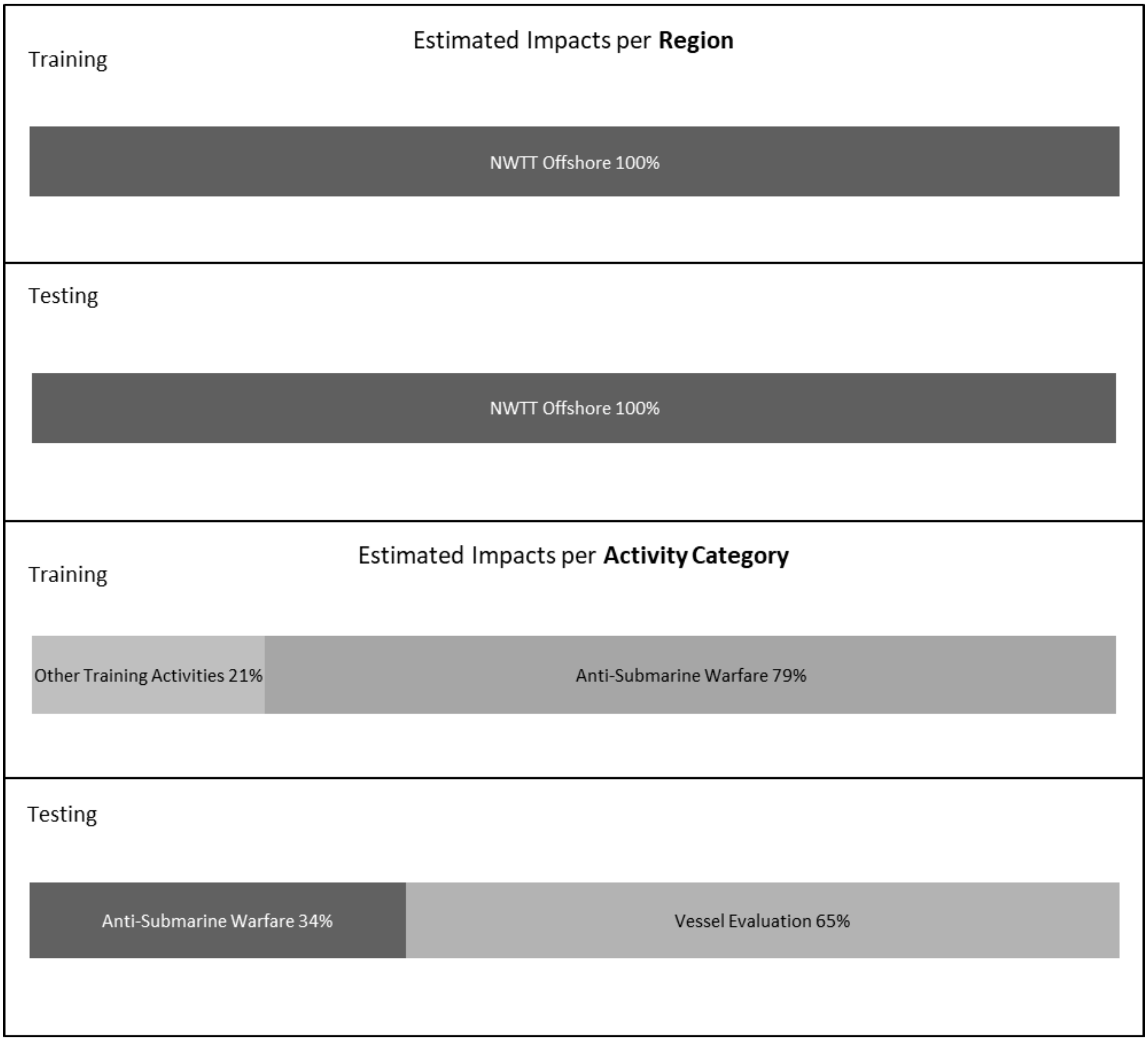
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of striped dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Striped dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-40 and Table 3.4-41). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-41).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of striped dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-40: Striped Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-41: Estimated Impacts on Individual Striped Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	426	13	0	337	7	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Striped dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-41 and Table 3.4-42). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-42).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

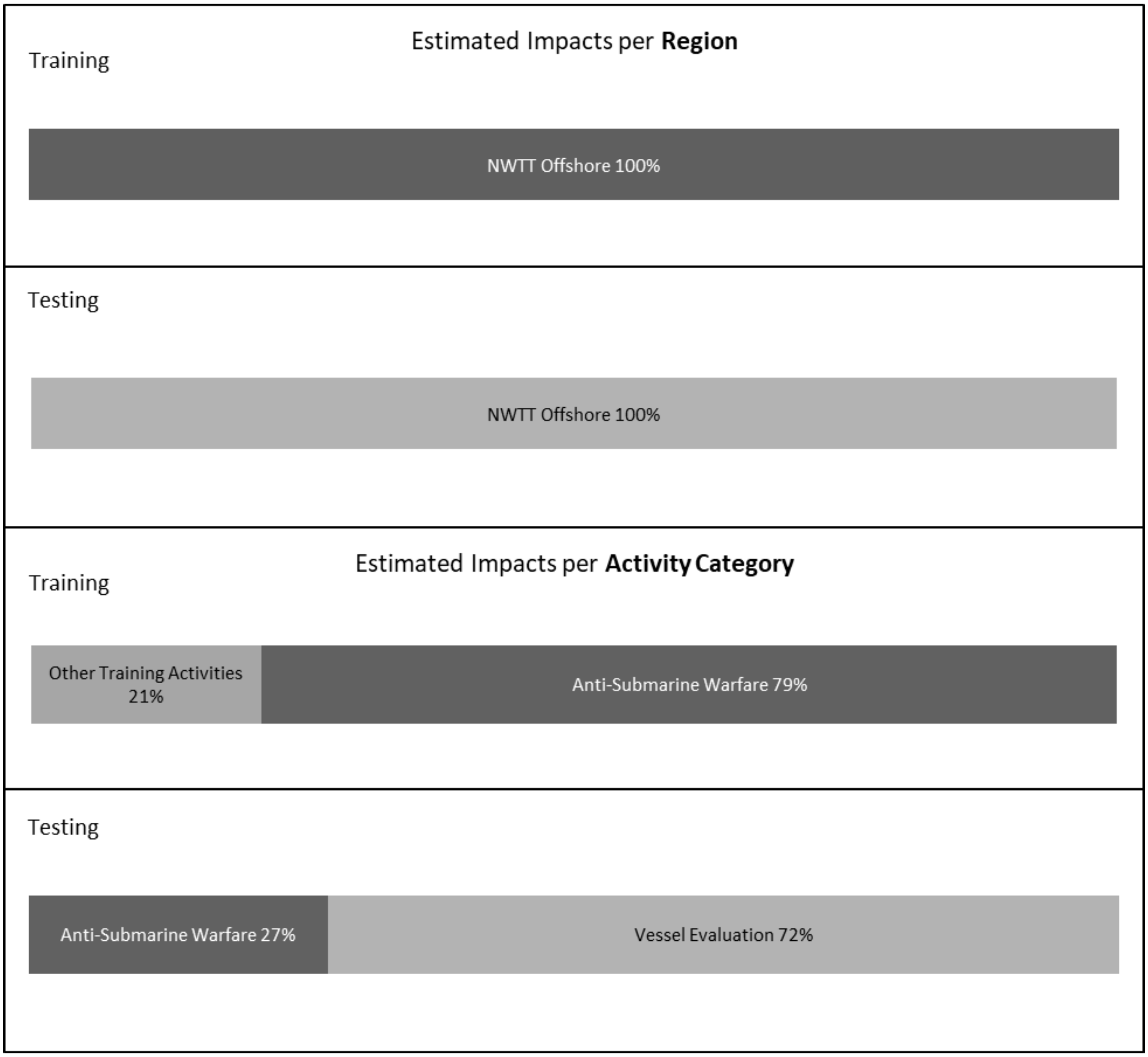
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of striped dolphins incidental to those activities.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Striped dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-41 and Table 3.4-42). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-42).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of striped dolphins incidental to those activities.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-41: Striped Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-42: Estimated Impacts on Individual Striped Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	432	13	0	466	8	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Kogia Whales

Kogia whales include two species that are often difficult to distinguish from one another: dwarf sperm whales and pygmy sperm whales; however, impacts to the populations of dwarf and pygmy sperm whales are modeled separately.

TTS and PTS thresholds for high-frequency cetaceans, such as Kogia whales are lower than for all other marine mammals, which leads to a higher number of estimated hearing loss impacts relative to the number of animals exposed to the sound as compared to other hearing groups (e.g., mid-frequency cetaceans).

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Kogia whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-42 and Table 3.4-43). Impact ranges for these species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts to Kogia whales (pygmy and dwarf sperm whales) apply to the California, Oregon, and Washington stocks (Table 3.4-43).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of Kogia whales (i.e., dwarf and pygmy sperm whales) incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

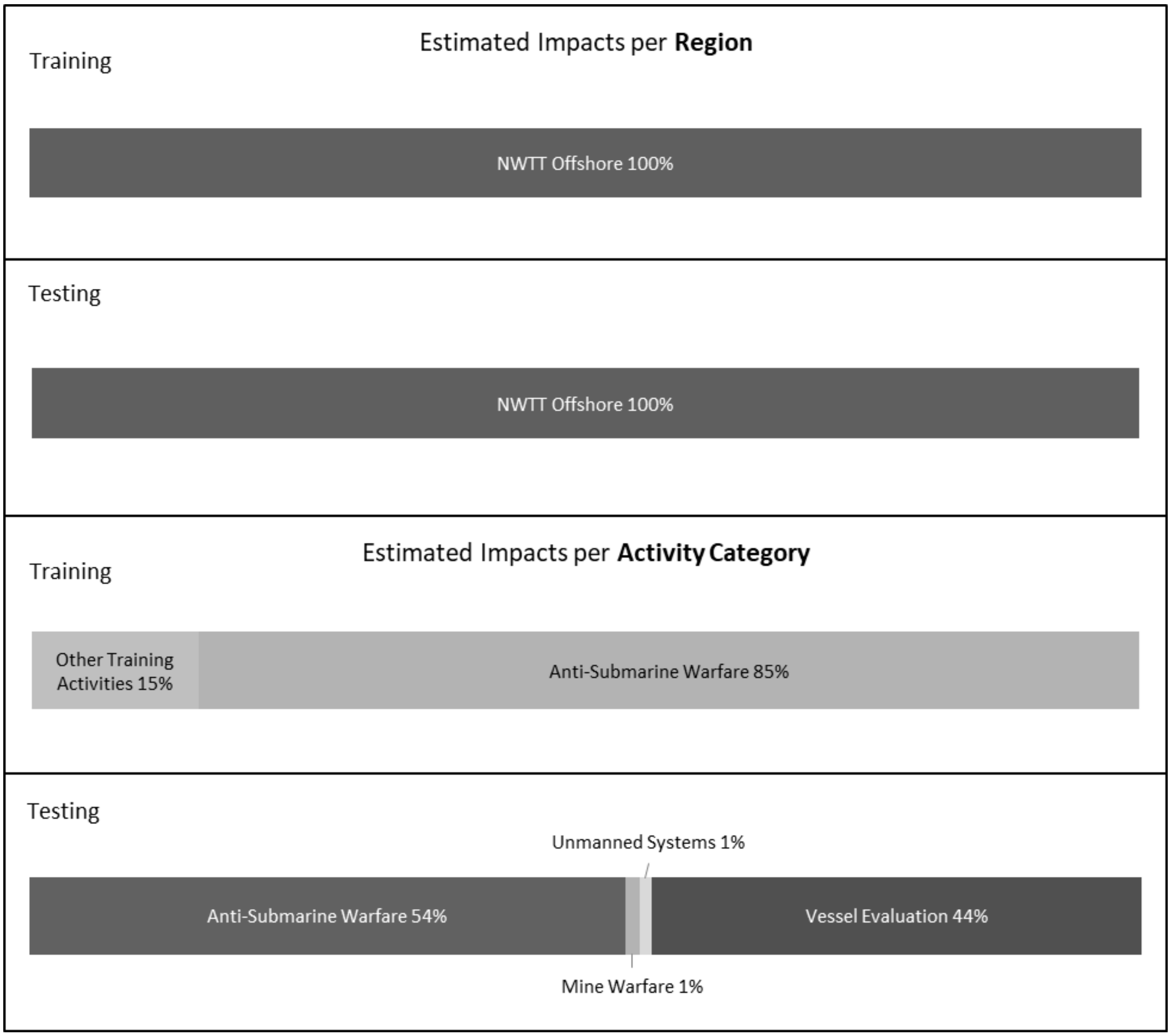
Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Kogia whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-42 and Table 3.4-43). Impact ranges for these species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts to Kogia whales (pygmy and dwarf sperm whales) apply to the California, Oregon, and Washington stocks (Table 3.4-43).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences

for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of Kogia whales (i.e., dwarf and pygmy sperm whales) incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-42: Kogia Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-43: Estimated Impacts on Kogia Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	204	178	0	160	336	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Kogia whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-43 and Table 3.4-44). Impact ranges for these species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts to Kogia whales (pygmy and dwarf sperm whales) apply to the California, Oregon, and Washington stocks (Table 3.4-44).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of Kogia whales (i.e., dwarf and pygmy sperm whales) incidental to those activities.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Kogia whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under Alternative 2 (Figure 3.4-43 and Table 3.4-44). Impact ranges for these species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts to Kogia whales (pygmy and dwarf sperm whales) apply to the California, Oregon, and Washington stocks (Table 3.4-44).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS could reduce an animal's ability to detect biologically important sounds; however, as discussed above, a small TS due to exposure to sonar is unlikely to affect the hearing range that Kogia whales rely upon. Nevertheless, PTS could have minor long-term consequences for individuals. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stock. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of Kogia whales (i.e., dwarf and pygmy sperm whales) incidental to those activities.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-43: Kogia Whales Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-44: Estimated Impacts on Individual Kogia Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	209	178	0	197	447	1

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Dall's Porpoises

TTS and PTS thresholds for high-frequency cetaceans, including Dall's porpoises, are lower than for all other marine mammals, which leads to a higher number of estimated impacts relative to the number of animals exposed to the sound as compared to other hearing groups (e.g., mid-frequency cetaceans). The information available on harbor porpoise behavioral reactions to human disturbance (a closely related species) suggests that these species may be more sensitive and avoid human activity, and sound sources, to a longer range than most other odontocetes. This would make Dall's porpoises less susceptible to hearing loss; therefore, it is likely that the quantitative analysis over-predicted hearing loss impacts (i.e., TTS and PTS) in Dall's porpoises.

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Dall's porpoises may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under Alternative 1 (Figure 3.4-44 and Table 3.4-45). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-45).

As described for odontocetes above, even a few TTS or behavioral reactions in an individual animal within a given year are unlikely to have any long-term consequences for that individual. PTS could reduce an animal's ability to detect biologically important sounds; however, as discussed above, hearing loss beyond a minor TTS is unlikely and a small TS due to exposure to sonar is unlikely to affect the hearing range that Dall's porpoise rely upon if it did occur. Nevertheless, PTS could have minor long-term consequences for individuals if it were to occur. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stock. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of Dall's porpoises incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Dall's porpoises may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under Alternative 1 (Figure 3.4-44 and Table 3.4-45). Impact ranges for this species are discussed in

Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-45).

As described for odontocetes above, even a few TTS or behavioral reactions in an individual animal within a given year are unlikely to have any long-term consequences for that individual. PTS could reduce an animal's ability to detect biologically important sounds; however, as discussed above, hearing loss beyond a minor TTS is unlikely and a small TS due to exposure to sonar is unlikely to affect the hearing range that Dall's porpoise rely upon if it did occur. Nevertheless, PTS could have minor long-term consequences for individuals if it were to occur. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of Dall's porpoises incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-44: Dall's Porpoise Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-45: Estimated Impacts on Individual Dall's Porpoise Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Alaska	0	0	0	179	459	0
California, Oregon, & Washington	6,911	6,368	6	6,440	13,729	24

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Dall's porpoise may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under Alternative 2 (Figure 3.4-45 and Table 3.4-46). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-46).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of Dall's porpoises incidental to those activities.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Dall's porpoise may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under Alternative 2 (Figure 3.4-45 and Table 3.4-46). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-46).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of Dall's porpoises incidental to those activities.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-45: Dall's Porpoise Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-46: Estimated Impacts on Individual Dall's Porpoise Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Alaska	0	0	0	204	574	0
California, Oregon, & Washington	7,088	6,419	6	7,766	18,074	29

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Harbor Porpoises

TTS and PTS thresholds for high-frequency cetaceans, including Harbor porpoise, are lower than for all other marine mammals, which leads to a higher number of estimated impacts relative to the number of animals exposed to the sound as compared to other hearing groups (e.g., mid-frequency cetaceans). Harbor porpoises are particularly sensitive to human-made noise and disturbance and will avoid sound levels between 120 and 140 dB re 1 µPa at distances up to 30 km for more intense activities (as discussed below). This means that the quantitative analysis greatly overestimates hearing loss in harbor porpoises because most animals would avoid sound levels that could cause TTS or PTS.

In addition to procedural mitigation, mitigation within the Stonewall and Heceta Bank Humpback Whale Mitigation Area will also help avoid or reduce potential impacts on harbor porpoises. Harbor porpoises are known to congregate for feeding at Heceta Bank. In this mitigation area, the Navy will not use surface ship hull-mounted MF1 mid-frequency active sonar during training and testing from May 1 to November 30.

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Harbor porpoises may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS per year under Alternative 1 (Figure 3.4-46 and Table 3.4-47). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-47).

As described for odontocetes above, even a few TTS or behavioral reactions in an individual animal within a given year are unlikely to have any long-term consequences for that individual. PTS could reduce an animal's ability to detect biologically important sounds; however, as discussed above, hearing loss beyond a minor TTS is unlikely and a small TS due to exposure to sonar is unlikely to affect the hearing range that harbor porpoise rely upon if it did occur. Nevertheless, PTS could have minor long-term consequences for individuals if it were to occur. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

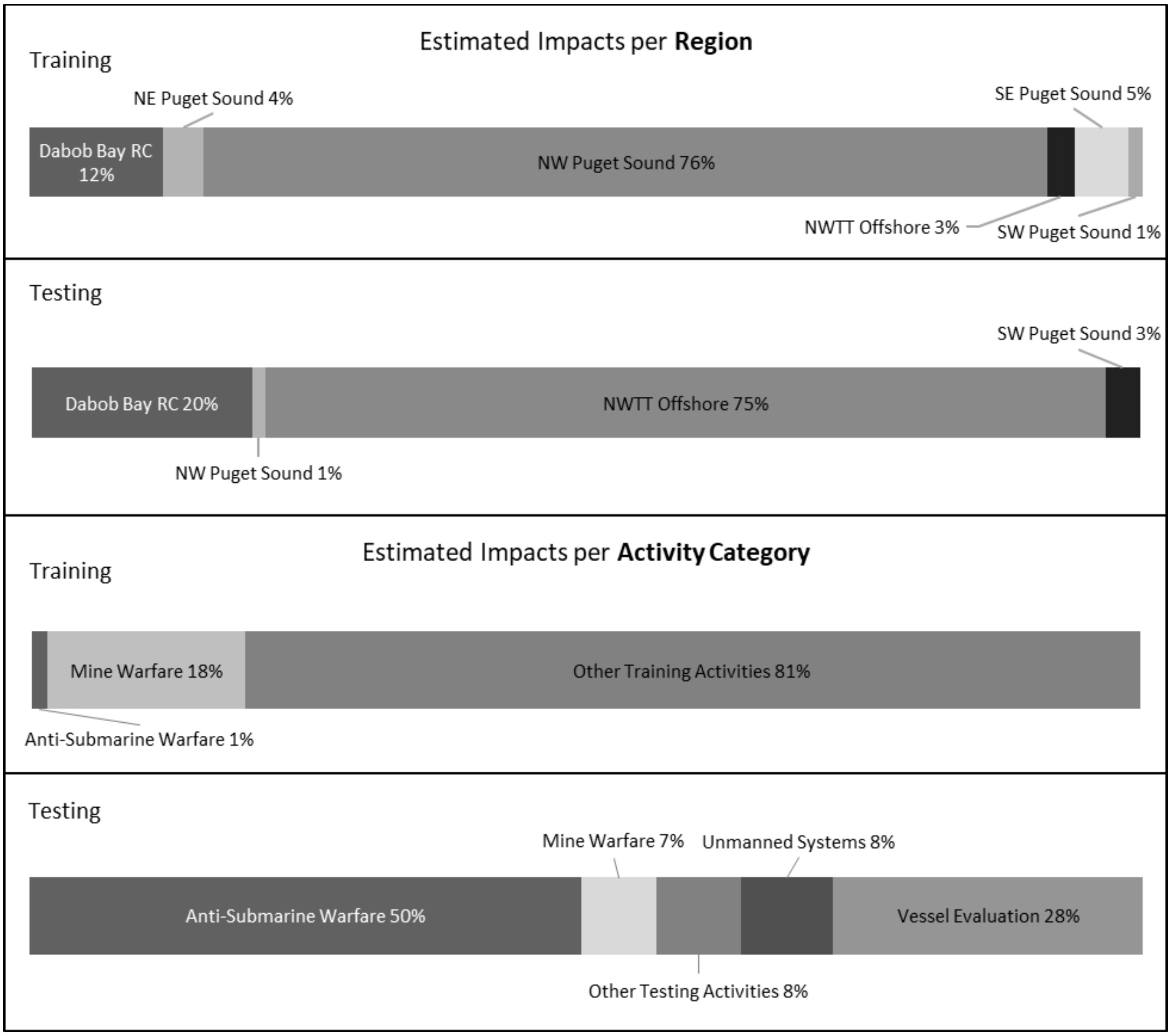
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of harbor porpoises incidental to those activities. The Navy has requested authorization from NMFS as required by section 101(a)(5)(A) of the MMPA.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Harbor porpoises may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS per year under Alternative 1 (Figure 3.4-46 and Table 3.4-47). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-47).

As described for odontocetes above, even a few TTS or behavioral reactions in an individual animal within a given year are unlikely to have any long-term consequences for that individual. PTS could reduce an animal's ability to detect biologically important sounds; however, as discussed above, hearing loss beyond a minor TTS is unlikely and a small TS due to exposure to sonar is unlikely to affect the hearing range that harbor porpoise rely upon if it did occur. Nevertheless, PTS could have minor long-term consequences for individuals if it were to occur. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of harbor porpoises incidental to those activities. The Navy has requested authorization from NMFS as required by section 101(a)(5)(A) of the MMPA.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-46: Harbor Porpoise Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-47: Estimated Impacts on Individual Harbor Porpoise Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	*Training*			*Testing*		
	Behavioral	*TTS*	*PTS*	*Behavioral*	*TTS*	*PTS*
Southeast Alaska	0	0	0	92	38	0
Northern Oregon/ Washington Coast	212	87	0	31,335	20,529	19
Northern California/ Southern Oregon	21	0	0	1,579	134	0
Washington Inland Waters	8,010	4,244	16	7,136	10,092	137

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Harbor porpoises may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS per year under Alternative 2. See Figure 3.4-47 or Appendix E (Estimated Marine Mammal and Sea Turtle Impacts from Exposure to Acoustic and Explosive Stressors under Navy Training and Testing Activities) for tabular results. Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-48).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

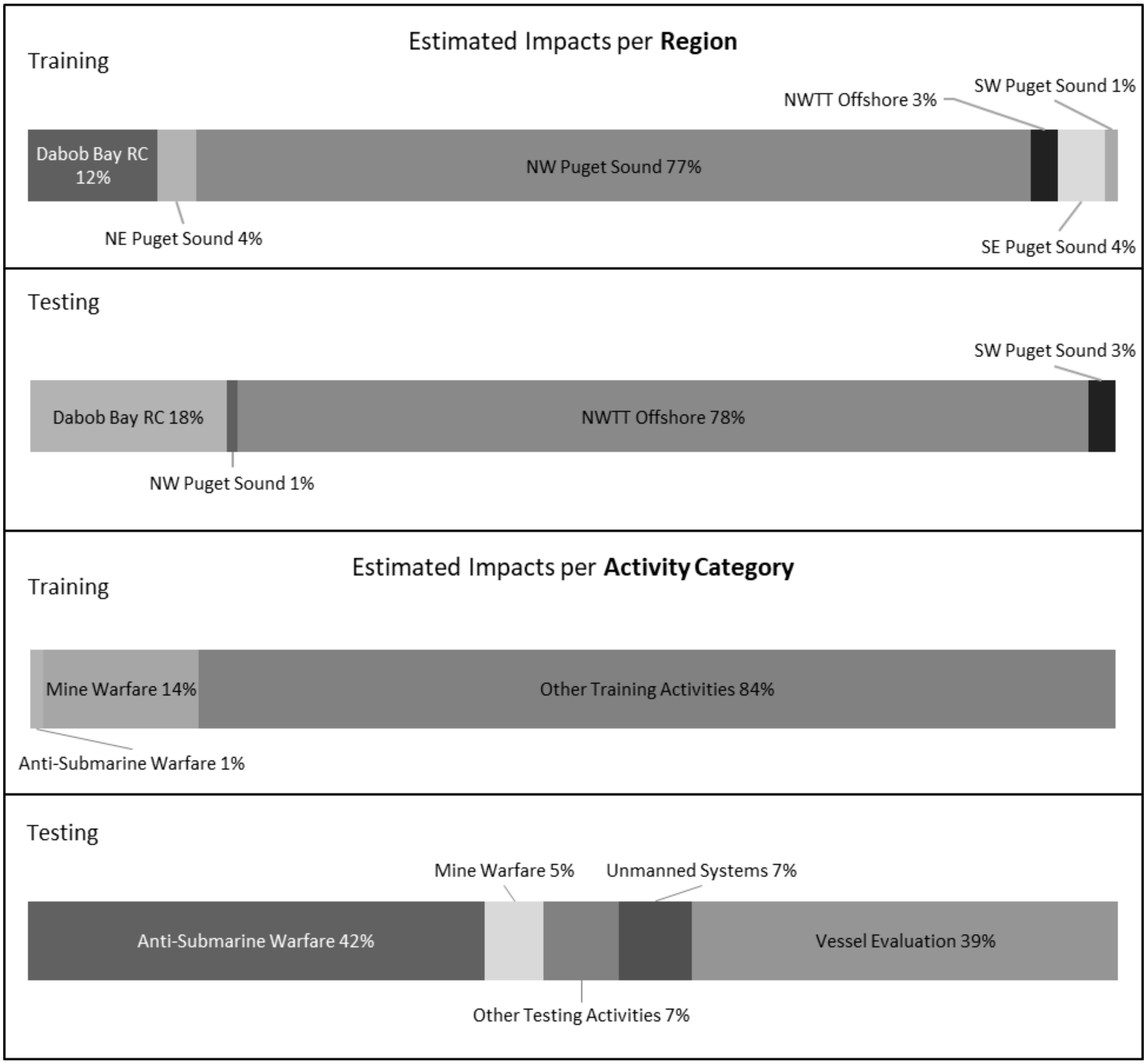
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of harbor porpoises incidental to those activities.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Harbor porpoises may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS per year under Alternative 2. See Figure 3.4-47 or Appendix E (Estimated Marine Mammal and Sea Turtle Impacts from Exposure to Acoustic and Explosive Stressors under Navy Training and Testing Activities) for tabular results. Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-48).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of harbor porpoises incidental to those activities.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-47: Harbor Porpoise Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-48: Estimated Impacts on Individual Harbor Porpoise Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	Training			Testing		
	Behavioral	TTS	PTS	Behavioral	TTS	PTS
Southeast Alaska	0	0	0	102	47	0
Northern Oregon/ Washington Coast	273	99	0	39,753	26,283	23
Northern California/ Southern Oregon	21	0	0	1,582	134	0
Washington Inland Waters	9,977	5,196	19	8,211	10,699	147

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Sperm Whales (Endangered Species Act-Listed)

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Sperm whales could be present in the Offshore Area of the Study Area, where they may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-48 and Table 3.4-49). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-49).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of sperm whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 1 may affect ESA-listed sperm whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Sperm whales could be present in the Offshore Area of the Study Area, where they may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-48 and Table 3.4-49). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for

Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-49).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of sperm whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 1 may affect ESA-listed sperm whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-48: Sperm Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-49: Estimated Impacts on Individual Sperm Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	510	2	0	324	3	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Sperm whales could be present in the Offshore Area of the Study Area, where they may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-49 and Table 3.4-50). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-50).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of sperm whales incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 2 may affect ESA-listed sperm whales.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Sperm whales could be present in the Offshore Area of the Study Area, where they may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-49 and Table 3.4-50). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-50).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of sperm whales incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 2 may affect ESA-listed sperm whales.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-49: Sperm Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-50: Estimated Impacts on Individual Sperm Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Stock	Training			Testing		
	Behavioral	TTS	PTS	Behavioral	TTS	PTS
California, Oregon, & Washington	519	2	0	427	4	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Beaked Whales

Beaked whales within the NWTT study area include Baird's beaked whale, Blainville's beaked whale, Cuvier's beaked whale, Hubb's beaked whale, Ginkgo-toothed beaked whale, Perrin's beaked whale, Stejneger's beaked whale, and the Pygmy beaked whale. Impacts to Blainville's beaked whale, Hubb's beaked whale, Ginkgo-toothed beaked whale, Perrin's beaked whale, Stejneger's beaked whale and the Pygmy beaked whale are combined and represented in the beaked whale guild (*Mesoplodon spp*.), as described in Section 9.1.2 of the Navy's NWTT Marine Species Density Database Technical Report (U.S. Department of the Navy, 2020).

As discussed above for odontocetes overall, the quantitative analysis overestimates hearing loss in marine mammals because behavioral response research has shown that most marine mammals are likely to avoid sound levels that could cause more than minor to moderate TTS (6–20 dB). Specifically for beaked whales, behavioral response research discussed below and in Section 3.4.2.1.1.5 (Behavioral Reactions), has demonstrated that beaked whales are sensitive to sound from sonars and usually avoid sound sources by 10 or more kilometers. These are well beyond the ranges to TTS for mid-frequency cetaceans such as beaked whales. Therefore, any TTS predicted by the quantitative analysis is unlikely to occur in beaked whales.

Research and observations (Section 3.4.2.1.1.5, Behavioral Reactions) show that if beaked whales are exposed to sonar or other transducers they may startle, break off feeding dives, and avoid the area of the sound source at levels ranging between 95 and 157 dB re 1 µPa (McCarthy et al., 2011). Furthermore, in research done at the Navy's fixed tracking range in the Bahamas and Hawaii, animals leave the immediate area of the anti-submarine warfare training exercise but return within a few days after the event ends (Henderson et al., 2015; Henderson et al., 2016; Manzano-Roth et al., 2016; Tyack et al., 2011). Populations of beaked whales and other odontocetes on Navy fixed ranges that have been operating for decades appear to be stable, and analysis is ongoing. Significant behavioral reactions seem likely in most cases if beaked whales are exposed to anti-submarine sonar within a few tens of kilometers, especially for prolonged periods (a few hours or more) since this is one of the most sensitive marine mammal groups to human-made sound of any species or group studied to date.

Based on the best available science, the Navy believes that beaked whales that exhibit a significant behavioral reaction due to sonar and other transducers during training or testing activities would generally not have long-term consequences for individuals or populations. However, because of a lack of scientific consensus regarding the causal link between sonar and stranding events, NMFS has stated in a letter to the Navy dated October 2006 that it "cannot conclude with certainty the degree to which mitigation measures would eliminate or reduce the potential for serious injury or mortality." The Navy does not anticipate that marine mammal strandings or mortality will result from the operation of sonar during Navy exercises within the Study Area. Additionally, through the MMPA process (which allows for adaptive management), NMFS and the Navy will determine the appropriate way to proceed in the event that a causal relationship were to be found between Navy activities and a future stranding.

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Beaked whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-50 through Figure 3.4-52, and Table 3.4-51 through Table 3.4-53). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts to Baird's beaked whales, Cuvier's beaked whale, and the small beaked whale guild (*Mesoplodon spp*.) apply to the California, Oregon, and Washington stocks (Table 3.4-51, Table 3.4-52, and Table 3.4-53).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of Baird's, Cuvier's, and Mesoplodon spp. beaked whales (species within the beaked whale guild) incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Beaked whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-50 through Figure 3.4-52, and Table 3.4-51 through Table 3.4-53). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts to Baird's beaked whales, Cuvier's beaked whale, and the small beaked whale guild (*Mesoplodon spp*.) apply to the California, Oregon, and Washington stocks (Table 3.4-51, Table 3.4-52, and Table 3.4-53).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of Baird's, Cuvier's, and Mesoplodon spp. beaked whales (species within the beaked whale guild) incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-50: Baird's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-51: Estimated Impacts on Individual Baird's Beaked Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	556	0	0	420	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-51: Cuvier's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-52: Estimated Impacts on Individual Cuvier's Beaked Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	1,461	1	0	1,074	3	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-52: Mesoplodon Spp. (Small Beaked Whale Guild) Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-53: Estimated Impacts on Individual Mesoplodon Spp. (Small Beaked Whale Guild) Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	651	1	0	468	2	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Beaked whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-53 through Figure 3.4-55, and Table 3.4-54 through Table 3.4-56). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts to Baird's beaked whales, Cuvier's beaked whale, and the small beaked whale guild (*Mesoplodon spp*.) apply to the California, Oregon, and Washington stocks (Table 3.4-54, Table 3.4-55, and Table 3.4-56).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

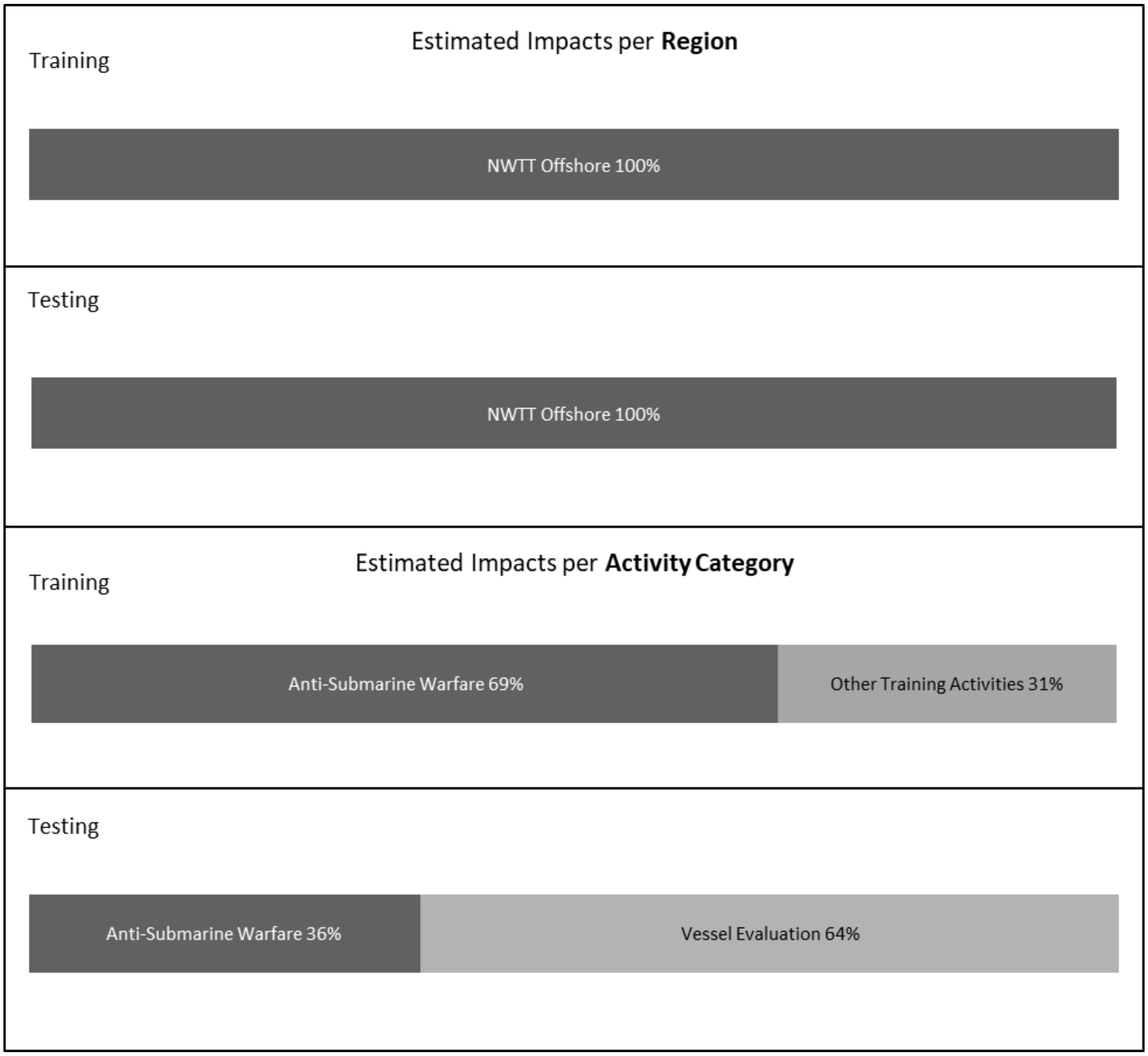
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of Baird's, Cuvier's, and Mesoplodon spp. beaked whales (species within the beaked whale guild) incidental to those activities.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Beaked whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-53 through Figure 3.4-55, and Table 3.4-54 through Table 3.4-56). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts to Baird's beaked whales, Cuvier's beaked whale, and the small beaked whale guild (*Mesoplodon spp*.) apply to the California, Oregon, and Washington stocks (Table 3.4-54, Table 3.4-55, and Table 3.4-56).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of Baird's, Cuvier's, and Mesoplodon spp. beaked whales (species within the beaked whale guild) incidental to those activities.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-53: Baird's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-54: Estimated Impacts on Individual Baird's Beaked Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	*Training*			*Testing*		
	Behavioral	*TTS*	*PTS*	*Behavioral*	*TTS*	*PTS*
California, Oregon, & Washington	559	0	0	578	1	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-54: Cuvier's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-55: Estimated Impacts on Individual Cuvier's Beaked Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	1,497	1	0	1,399	4	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-55: Mesoplodon Spp. (Small Beaked Whale Guild) Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-56: Estimated Impacts on Individual Mesoplodon Spp. (Small Beaked Whale Guild) Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California, Oregon, & Washington	666	1	0	609	2	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Pinnipeds and Mustelids

Pinnipeds include phocid seals (true seals) and otariids (sea lions and fur seals), and mustelids include sea otters.

Pinnipeds may be exposed to sound from sonar and other transducers associated with training and testing activities throughout the year. Low- (less than 1 kHz), mid- (1–10 kHz), and high-frequency (10–100 kHz) sonars produce sounds that are likely to be within the audible range of pinnipeds (see Section 3.4.1.6, Hearing and Vocalization). Comparatively, hearing sensitivities are significantly reduced in mustelids and exposure to these sounds may have lower overall severity. If a sound is within an animal's hearing range then behavioral reactions, physiological stress, masking and hearing loss are potential impacts that must be analyzed. If a marine mammal cannot hear a sound, then behavioral reactions, physiological stress, masking, or hearing loss could not occur. Impact ranges for pinnipeds and mustelids are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers).

There is no research on the effects of sonar on sea otters. As described in Section 3.4.2.1.1.5 (Behavioral Reactions), mustelids have similar or reduced hearing capabilities compared to pinnipeds (specifically otariids). Thus, it is reasonable to assume that mustelids use their hearing similarly to that of otariids, and the types of impacts from exposure to sonar and other transducers may also be similar to those described below for pinnipeds, including behavioral reactions, physiological stress, masking, and hearing loss; however, because mustelids spend the majority of their time with their heads above or at the water's surface and live nearshore, they are less likely to be exposed to or impacted by sonars and other transducers used in testing and training.

A few behavioral reactions by pinnipeds resulting from exposure to sonar could take place at distances of up to 10 km. Behavioral reactions, however, are much more likely within a kilometer or less of the sound source (see Section 3.4.2.1.1.5, Behavioral Reactions). As discussed above in *Assessing the Severity of Behavioral Responses from Sonar*, the quantitative analysis very likely overestimated the numbers of behavioral reactions due to the underlying nature of the data used to derive the behavioral response functions. Research shows that pinnipeds in the water are generally tolerant of human-made sound and activity, while mustelids have reduced underwater hearing abilities (see Section 3.4.2.1.1.5, Behavioral Reactions). If pinnipeds or mustelids are exposed to sonar or other transducers, they may react in various ways, depending on their experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Pinnipeds or mustelids may not react at all until the sound source is approaching within a few hundred meters and then may alert, ignore the stimulus, change their behaviors, or avoid the immediate area by swimming away or diving. Significant behavioral reactions would not be expected in most cases, and long-term consequences for individual pinnipeds or mustelids from a single or several impacts per year are unlikely. Behavioral research indicates that most pinnipeds probably avoid sound sources at levels that could cause higher levels of TTS (greater than 20 dB of TTS) and PTS. Recovery from TTS begins almost immediately after the noise exposure ceases and can take a few minutes to a few days to fully recover, depending on the magnitude of the initial TS. Most TTS, if it does actually occur, would be more likely to be minor to moderate (i.e., less than 20 dB of TTS directly after the exposure) and would recover within a matter of minutes to hours. Threshold shifts do not necessarily affect all hearing frequencies equally, and typically manifest themselves at the exposure frequency or within an octave above the exposure frequency. During the short period that a pinniped had TTS, social calls from conspecifics could be more difficult to detect or interpret. Killer whales are a primary predator of pinnipeds. Some TTS could make killer whale calls more difficult to detect at further ranges until hearing recovers. Pinnipeds probably use sound and vibrations to find and capture prey underwater. Therefore, it could be more difficult for pinnipeds with TTS to locate food for a short period before their hearing recovers. Because TTS would likely be minor to moderate (less than 20 dB of TTS), costs would be short-term and could be recovered. A single or even a few mild to moderate TTS per year are unlikely to have any long-term consequences for that individual.

Research and observations of masking in marine mammals are discussed in Section 3.4.2.1.1.4 (Masking). Many low- (less than 1 kHz), mid- (1–10 kHz), and high-frequency (10–100 kHz) sonars produce sounds that are likely to be within the hearing range of pinnipeds and potentially mustelids. Many anti-submarine warfare (anti-submarine warfare) sonars and countermeasures use low- and mid-frequency ranges. Most low- and mid-frequency sonar signals (i.e., sounds) are limited in the temporal, frequency, and spatial domains. The duration of most individual sounds is short, lasting up to a few seconds each. Some systems operate with higher duty cycles or nearly continuously, but typically use lower power. Nevertheless, masking may be more prevalent at closer ranges to these high-duty cycle and continuous active sonar systems. Most anti-submarine warfare activities are geographically dispersed and last for only a few hours, often with intermittent sonar use even within this period. Most anti-submarine warfare sonars also have a narrow frequency band (typically less than one-third octave). These factors reduce the likelihood of sources causing significant masking in pinnipeds due to exposure to sonar used during anti-submarine warfare activities. Pinnipeds and mustelids may experience some limited masking at closer ranges from high-frequency sonars and other transducers; however, the frequency band of the sonar is narrow, limiting the likelihood of masking. Sonars that employ high frequencies are typically used for mine hunting, navigation, and object detection (avoidance). Potential costs to pinnipeds and mustelids from masking are similar to those discussed above for mild to moderate levels of TTS, with the primary difference being that the effects of masking are only present when the sound source (i.e., sonar) is actively transmitting and the effect is over the moment the sound has ceased. Nevertheless, pinnipeds that do experience some masking for a short period from sonar or other transducers may have their ability to communicate with conspecifics reduced, especially at further ranges. Sounds from mid-frequency sonar could mask killer whale vocalizations making them more difficult to detect, especially at further ranges. Pinnipeds probably use sound and vibrations to find and capture prey underwater. Therefore, it could be more difficult for pinnipeds to locate food if masking is occurring. A single or even a few short periods of masking, if it were to occur, to an individual pinniped or mustelid per year are unlikely to have any long-term consequences for that individual.

California Sea Lions

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

California sea lions may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-56 and Table 3.4-57). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the U.S. stock (Table 3.4-57).

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

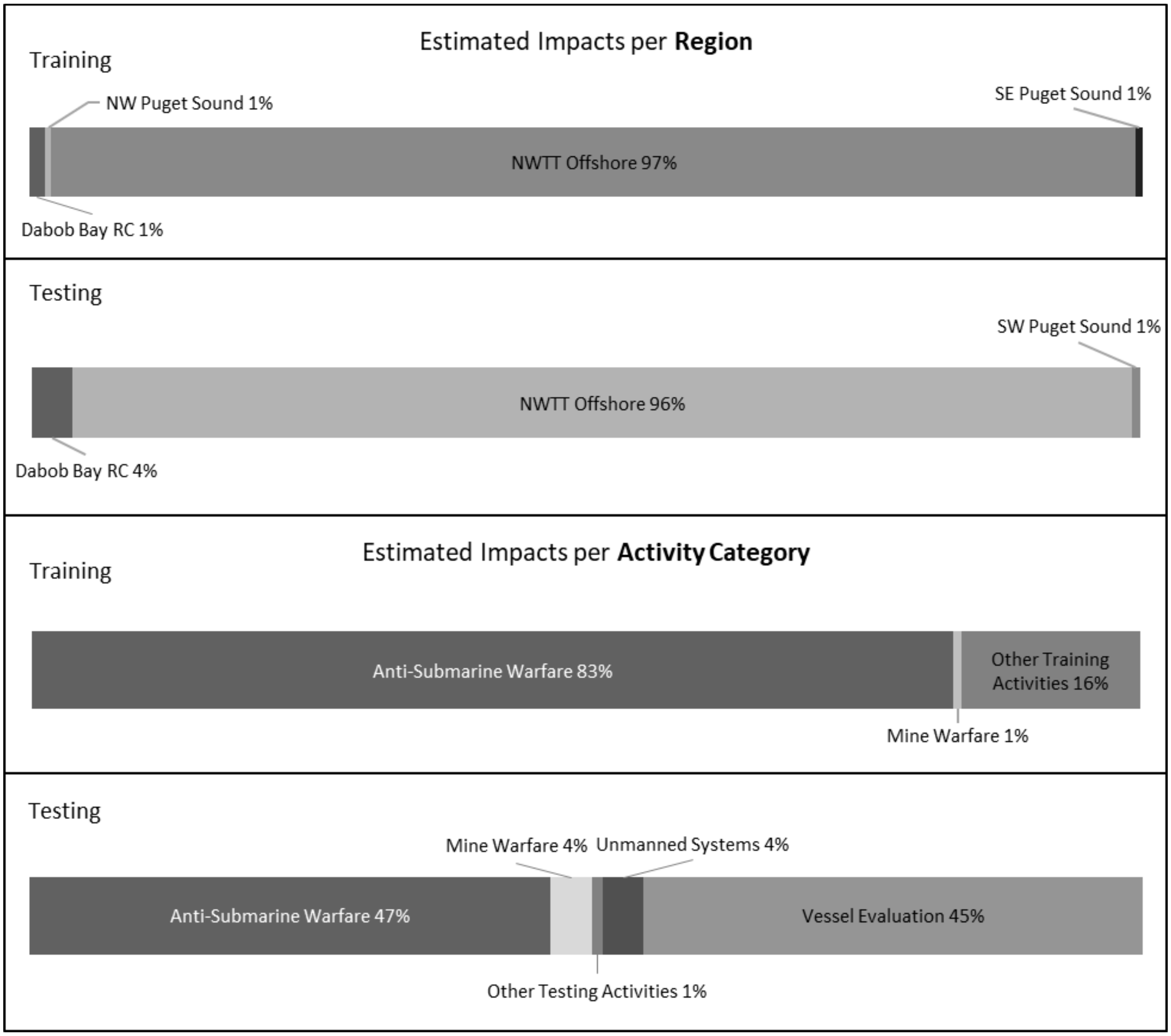
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of California sea lions incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

California sea lions may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-56 and Table 3.4-57). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the U.S. stock (Table 3.4-57).

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stock. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking California sea lions incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-56: California Sea Lion Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-57: Estimated Impacts on Individual California Sea Lion Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
U.S. Stock	3,615	9	0	20,140	330	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

California sea lions may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-57 and Table 3.4-58). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the U.S. stock (Table 3.4-58).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of California sea lions incidental to those activities.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

California sea lions may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-57 and Table 3.4-58). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the U.S. stock (Table 3.4-58).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking California sea lions incidental to those activities.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-57: California Sea Lion Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-58: Estimated Impacts on Individual California Sea Lion Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
U.S. Stock	3,698	9	0	27,015	340	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Steller Sea Lions (one DPS is Endangered Species Act-Listed)

The Eastern U.S. stock of Steller sea lions is not listed under the Endangered Species Act. All impacts estimated by the quantitative analysis are on the Eastern U.S. stock. The Western U.S. stock of Steller sea lions is listed endangered under the ESA; however, Steller sea lions from the Western U.S. stock are rare in the Study Area.

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Steller sea lions may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-58 and Table 3.4-59). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Eastern U.S. stock (Table 3.4-59).

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of Steller sea lions incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 1 may affect ESA-listed Steller sea lions. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Steller sea lions may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-58 and Table 3.4-59). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Eastern U.S. stock (Table 3.4-59).

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stock. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking Steller sea lions incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 1 may affect ESA-listed Steller sea lions. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-58: Steller Sea Lion Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-59: Estimated Impacts on Individual Steller Sea Lion Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Eastern U.S.	107	1	0	2,124	5	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Steller sea lions may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-59 and Table 3.4-60). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Eastern U.S. stock (Table 3.4-60).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of Steller sea lions incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 2 may affect ESA-listed Steller sea lions.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Steller sea lions may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-59 and Table 3.4-60). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Eastern U.S. stock (Table 3.4-60).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking Steller sea lions incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 2 may affect ESA-listed Steller sea lions.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-59: Steller Sea Lion Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-60: Estimated Impacts on Individual Steller Sea Lion Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	*Training*			*Testing*		
	Behavioral	*TTS*	*PTS*	*Behavioral*	*TTS*	*PTS*
Eastern U.S.	114	1	0	2,701	6	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Guadalupe Fur Seals (Endangered Species Act-listed)

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Guadalupe fur seals are present within the coastal margins of the offshore portion of the Study Area during the warm season (summer and early autumn), where they may be exposed to sounds from sonar and other transducers associated with training activities. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-60 and Table 3.4-61). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Mexico stock (Table 3.4-61).

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stock. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of Guadalupe fur seals incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 1 may affect ESA-listed Guadalupe fur seals. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

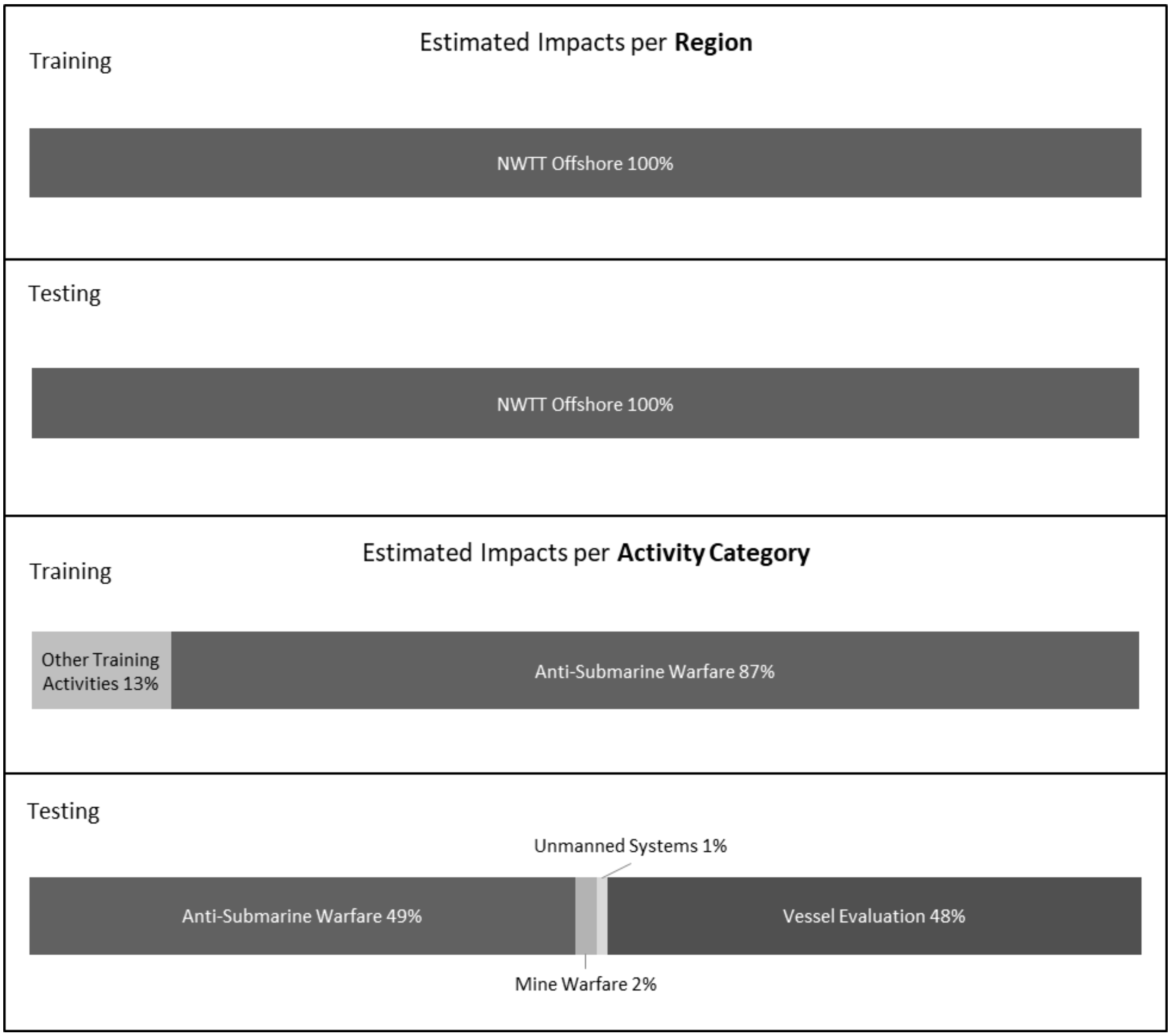
Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Guadalupe fur seals are present within the coastal margins of the offshore portion of the Study Area during the warm season (summer and early autumn), where they may be exposed to sounds from sonar and other transducers associated with testing activities. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-60 and Table 3.4-61). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Mexico stock (Table 3.4-61).

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stock. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of Guadalupe fur seals incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 1 may affect ESA-listed Guadalupe fur seals. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-60: Guadalupe Fur Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-61: Estimated Impacts on Individual Guadalupe Fur Seal Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Mexico	605	3	0	877	10	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Guadalupe fur seals are present within the coastal margins of the offshore portion of the Study Area during the warm season (summer and early autumn), where they may be exposed to sounds from sonar and other transducers associated with training activities. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-61 and Table 3.4-62). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Mexico stock (Table 3.4-62).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of Guadalupe fur seals incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 2 may affect ESA-listed Guadalupe fur seals.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Guadalupe fur seals are present within the coastal margins of the offshore portion of the Study Area during the warm season (summer and early autumn), where they may be exposed to sounds from sonar and other transducers associated with testing activities. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-61 and Table 3.4-62). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the Mexico stock (Table 3.4-62).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of Guadalupe fur seals incidental to those activities.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 2 may affect ESA-listed Guadalupe fur seals.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-61: Guadalupe Fur Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-62: Estimated Impacts on Individual Guadalupe Fur Seal Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Mexico	617	3	0	1,152	10	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Northern Fur Seals

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Northern fur seals may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-62 and Table 3.4-63). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-63).

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of northern fur seals incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Northern fur seals may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-62 and Table 3.4-63). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-63).

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of Northern fur seals incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-62: Northern Fur Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-63: Estimated Impacts on Individual Northern Fur Seal Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Eastern Pacific	2,130	4	0	9,332	126	0
California	43	0	0	188	1	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Northern fur seals may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-63 and Table 3.4-64). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-64).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

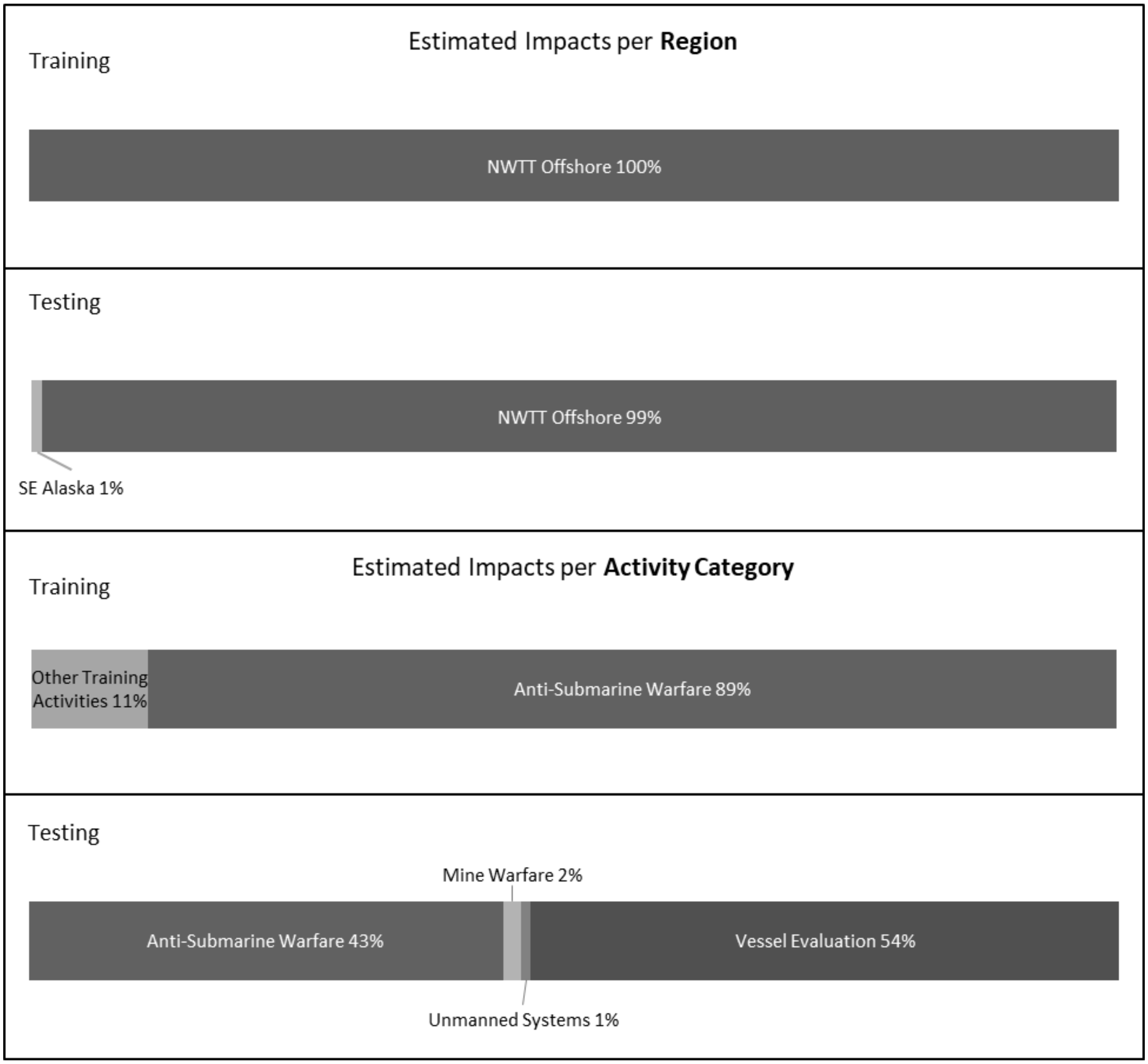
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of northern fur seals incidental to those activities.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Northern fur seals may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-63 and Table 3.4-64). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-64).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking of Northern fur seals incidental to those activities.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-63: Northern Fur Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-64: Estimated Impacts on Individual Northern Fur Seal Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Eastern Pacific	2,162	4	0	12,102	128	0
California	44	0	0	244	1	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Harbor Seals

<u>Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities</u>

Harbor seals may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under Alternative 1 (Figure 3.4-64 and Table 3.4-65). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-65).

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS could reduce an animal's ability to detect biologically important sounds; however, as discussed above, hearing loss beyond a minor TTS is unlikely. Nevertheless, PTS could have minor long-term consequences for individuals if it were to occur. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of harbor seals incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

<u>Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities</u>

Harbor seals may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under Alternative 1 (Figure 3.4-64 and Table 3.4-65). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-65).

As described above, a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have significant costs or long-term consequences for that individual. PTS could reduce an animal's ability to detect biologically important sounds; however, as discussed above, hearing loss beyond a minor TTS is unlikely. Nevertheless, PTS could have minor long-term consequences for individuals if it were to occur. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks.

Because the density of Hood Canal harbor seals is very high in the vicinity of testing ranges in the Inland Waters, the quantitative analysis indicates that the Hood Canal stock of harbor seals would experience more instances of TTS or behaviorally responding to sonars. The quantitative analysis does not account for the potential for a harbor seal in Inland Waters to minimize underwater sound exposure by hauling out or otherwise avoiding exposures that may cause TTS, and it is likely that this stock of harbor seals is not naïve to the sounds produced during Navy testing.

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of harbor seals incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-64: Harbor Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-65: Estimated Impacts on Individual Harbor Seal Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Southeast Alaska - Clarence Strait	0	0	0	2,077	275	0
Oregon/Washington Coastal	0	0	0	531	629	0
Washington Northern Inland Waters	436	203	0	434	144	0
Hood Canal	2,334	348	0	36,096	22,688	0
Southern Puget Sound	730	360	1	2,544	3,204	3

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Harbor seals may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under Alternative 2 (Figure 3.4-65 and Table 3.4-66). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-66).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of harbor seals incidental to those activities.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Harbor seals may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under Alternative 2 (Figure 3.4-65 and Table 3.4-66). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (Table 3.4-66).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking harbor seals incidental to those activities.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-65: Harbor Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-66: Estimated Impacts on Individual Harbor Seal Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
Southeast Alaska - Clarence Strait	0	0	0	2,513	312	0
Oregon/Washington Coastal	1	0	0	602	801	0
Washington Northern Inland Waters	509	227	0	434	144	0
Hood Canal	2,881	417	0	37,814	25,594	0
Southern Puget Sound	822	398	1	2,565	3,204	3

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Northern Elephant Seals

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Northern elephant seals may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-66 and Table 3.4-67). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California stock (Table 3.4-67).

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stock. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 1 will result in the unintentional taking of northern elephant seals incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

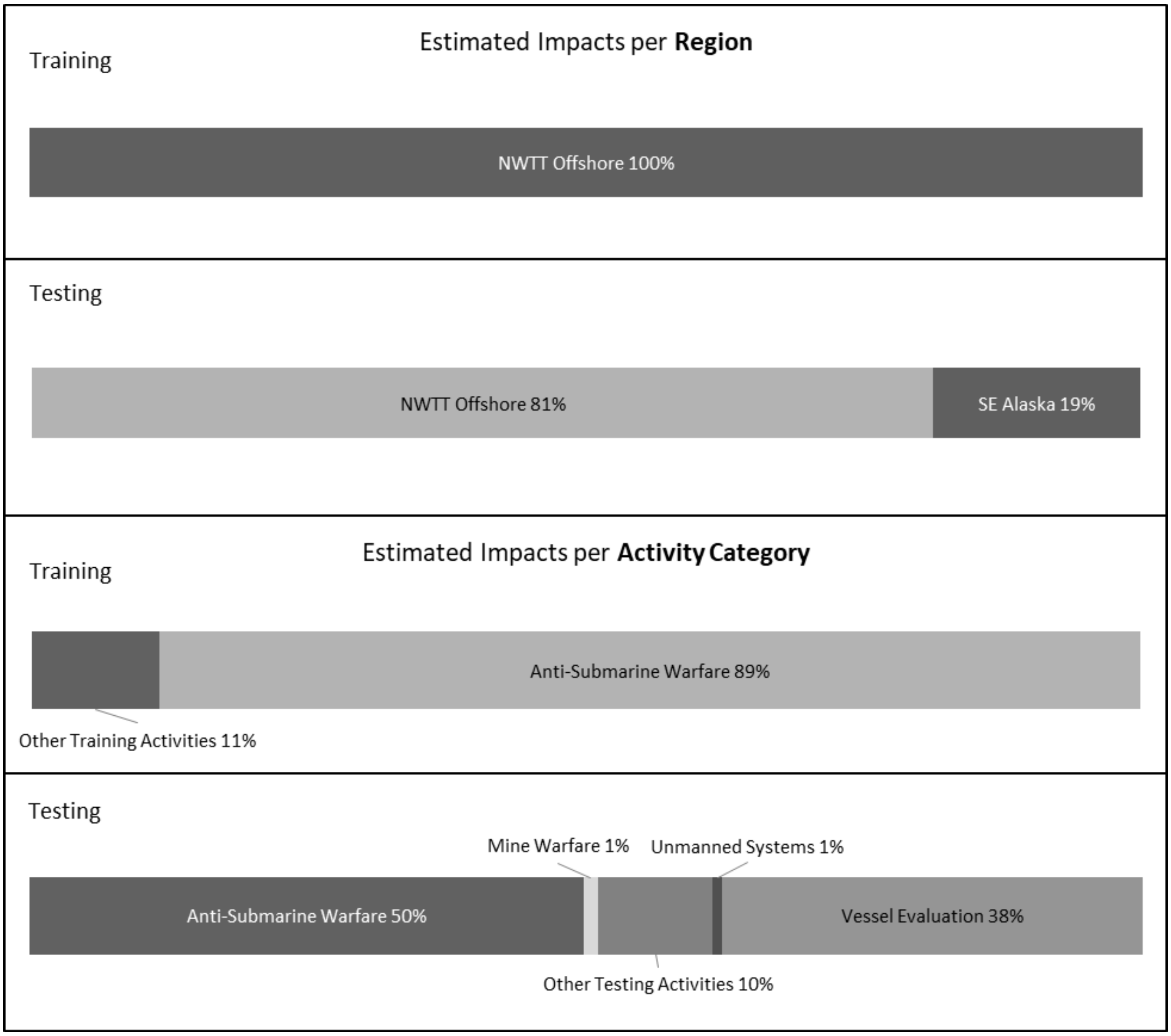
Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Northern elephant seals may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1 (Figure 3.4-66 and Table 3.4-67). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California stock (Table 3.4-67).

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual.

This minor consequence for an individual is unlikely to have any long-term consequences for the species or stock. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 1 will result in the unintentional taking of Northern elephant seals incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-66: Northern Elephant Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Table 3.4-67: Estimated Impacts on Individual Northern Elephant Seal Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California	1,698	209	0	2,429	491	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Northern elephant seals may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-67 and Table 3.4-68). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California stock (Table 3.4-68).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under Alternative 2 will result in the unintentional taking of northern elephant seals incidental to those activities.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Northern elephant seals may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2 (Figure 3.4-67 and Table 3.4-68). Impact ranges for this species are discussed in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to the California stock (Table 3.4-68).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under Alternative 2 will result in the unintentional taking Northern elephant seals incidental to those activities.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-67: Northern Elephant Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Table 3.4-68: Estimated Impacts on Individual Northern Elephant Seal Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts by Effect						
Stock	***Training***			***Testing***		
	Behavioral	***TTS***	***PTS***	***Behavioral***	***TTS***	***PTS***
California	1,735	209	0	3,149	612	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Northern Sea Otters

Sea otters that occur along the coast of Washington are the result of reintroduction efforts of the northern sea otter (from Amchitka Island, Alaska) in 1969 and 1970 (Lance et al., 2004; Sato, 2018), and are not listed as threatened or endangered under the ESA (Carretta et al., 2017c). There is a single stock in Washington waters (the northern sea otter [*Enhydra lutris kenyoni*]) and a single stock in California (the southern sea otter [*Enhydra lutris nereis*]). Only the Washington stock of sea otter is known to occur in the Study Area (Carretta et al., 2017c) and is expected to only be present in the shallow, nearshore areas of the Offshore portion of the Study Area.

Sea otters seldom range more than 2 km from shore, because they are benthic foragers and limited by their ability to dive to the seafloor, although some individuals, particularly juvenile males, may travel farther offshore (Calambokidis et al., 1987; Laidre et al., 2009; Muto et al., 2017; Riedman & Estes, 1990). Additional information about potential sea otter distribution offshore is in Section 3.4.1.37 (Northern Sea Otter). Ghoul and Reichmuth (2014b) have shown that sea otters are not especially well adapted for hearing underwater, which suggests that the function of this sense has been less important in their survival and evolution than in comparison to pinnipeds. Sea otters in this region are mainly concentrated off the coast of the Olympic Peninsula and the western Strait of Juan de Fuca, with only rare sightings in Puget Sound. Sea otters do not typically occur in Inland Waters, thus activities occurring in these areas would not overlap with sea otter presence.

Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities

Exposures of sea otters to sonar and other transducers are unlikely because sea otters primarily inhabit shallow coastal areas outside of areas where sonars and other transducers are used in training, plus they spend the majority of their time floating at the surface with their ears above the water. Sea otters would be far outside of the distance of any possible auditory impacts from any source. Sea otters would need to be underwater to hear sonar, and sound propagation into shallow water, kelp forest habitat may be limited.

The quantitative analysis predicts no impacts to sea otters under Alternative 1. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Due to their low sensitivity to underwater sounds, their preferred habitat, their behavioral pattern of spending a majority of their time above water, and the short range to effects as described in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers), impacts to northern sea otters from Navy training activities involving sonar and other transducers are highly unlikely to occur.

Pursuant to the MMPA, the use of sonar during training activities as described under Alternative 1 would not result in the incidental taking of Northern sea otters.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities

Exposures of sea otters to sonar and other transducers are unlikely because sea otters primarily inhabit shallow coastal areas outside of areas where sonars and other transducers are used in training, plus they spend the majority of their time floating at the surface with their ears above the water. Sea otters would be far outside of the distance of any possible auditory impacts from any source. Sea otters would need to be underwater to hear sonar, and sound propagation into shallow water, kelp forest habitat may be limited.

The quantitative analysis predicts no impacts to sea otters under Alternative 1. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Due to their low sensitivity to underwater sounds, their preferred habitat, their behavioral pattern of spending a majority of their time above water, and the short range to effects as described in Section 3.4.2.1.2.2 (Impact Ranges for Sonar and Other Transducers), impacts to northern sea otters from Navy testing activities involving sonar and other transducers are highly unlikely to occur.

Pursuant to the MMPA, the use of sonar during testing activities as described under Alternative 1 would not result in the incidental taking of Northern sea otters.

Impacts from Sonar and Other Transducers Under Alternative 2 for Training Activities

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with training activities under Alternative 2.

Pursuant to the MMPA, the use of sonar during training activities as described under Alternative 2 would not result in the incidental taking of Northern sea otters.

Impacts from Sonar and Other Transducers Under Alternative 2 for Testing Activities

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the potential for impacts would increase slightly based on the slight increase in sonar use associated with testing activities under Alternative 2.

Pursuant to the MMPA, the use of sonar during testing activities as described under Alternative 2 would not result in the incidental taking of Northern sea otters.

3.4.2.1.2.4 Impacts from Sonar and Other Transducers Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct proposed at-sea training and testing activities in the Study Area. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities. Discontinuing the training and testing activities would result in fewer acoustic stressors (e.g., sonar and other transducers) within the marine environment where Navy activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for impacts from sonar and other transducers on marine mammals, but would not measurably improve the overall distribution or abundance of marine mammals.

3.4.2.1.3 Impacts from Vessel Noise

Marine mammals may be exposed to noise from vessel movement. A detailed description of the acoustic characteristics and typical sound levels of vessel noise are in Section 3.0.3.1.2 (Vessel Noise). Vessel movements involve transits to and from ports to various locations within the Study Area, including commercial ship traffic as well as recreational vessels in addition to U.S. Navy vessels. Many ongoing and proposed training and testing activities within the Study Area involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels). Section 3.4.2.1.1 (Background) summarizes and synthesizes available information on behavioral reactions, masking, and physiological stress due to noise exposure, including vessel noise (Sections 3.4.2.1.1.2, Hearing Loss; 3.4.2.1.1.3, Physiological Stress; 3.4.2.1.1.4, Masking; and 3.4.2.1.1.5, Behavioral Reactions).

Activities may vary slightly from those previously analyzed in the 2015 NWTT Final EIS/OEIS, but the overall determinations presented remain valid. Increases and decreases shown in Tables 2.5-1, 2.5-2, and 2.5-3 for proposed training and testing activities under Alternative 1 and 2 do not appreciably change the impact conclusions presented in the 2015 NWTT Final EIS/OEIS. The Navy will implement mitigation measures for vessel movement to avoid the potential for marine mammal vessel strikes, as discussed in Section 5.3.4.1 (Vessel Movement). The mitigation for vessel movement (i.e., maneuvering to maintain a specified distance from a marine mammal) will also help the Navy avoid or reduce potential impacts from vessel noise on marine mammals.

Sound from naval vessels during training and testing activities would overlap proposed critical habitat for the ESA-listed Central America and Mexico DPSs of humpback whales in the Offshore Area. As described in Section 3.4.1.13 (Humpback Whale [*Megaptera novaeangliae*]), one essential feature was identified for humpback whale critical habitat: prey species, primarily euphausiids and small pelagic schooling fishes, of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth. Although vessel noise may elicit a brief response from individual prey species in close proximity to a vessel, noise from naval vessels during training and testing activities presents no plausible route of impact to prey species of sufficient quantity, abundance, and accessibility.

Sound from naval vessels during training and testing activities would overlap ESA-listed Southern Resident DPS designated critical habitat in the Inland Waters and proposed critical habitat in the Offshore Area. Essential features for the conservation of the Southern Resident DPS critical habitat for the designated inland areas (National Marine Fisheries Service: Northwest Region, 2006) and proposed offshore areas include (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging. None of these essential features would be adversely affected by vessel noise resulting from this action, as follows:

1. Noise from naval vessels would not have a plausible route to affect the physical nature of water quality as defined under critical habitat.
2. Although vessel noise may elicit a brief response from individual prey species in close proximity to a vessel, noise from naval vessels during training and testing activities presents no plausible route of impact to prey species of sufficient quantity, quality, and availability. The minor, infrequent contribution of naval vessel noise to background noise would not chronically reduce effective foraging echolocation space in critical habitat.

3. Procedural mitigations are designed to limit the potential for vessel interactions to disturb the Southern Resident DPS, and infrequent and transient noise from naval vessels would not obstruct waterways or impact the conservation function of passage conditions to allow for migration, resting, and foraging in designated critical habitat.

Under the No Action Alternative, the Navy would not conduct proposed at-sea training and testing activities in the Study Area. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities. Discontinuing the training and testing activities would result in fewer acoustic stressors (e.g., vessel noise) within the marine environment where activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for impacts from vessel noise on marine mammals, but would not measurably improve the overall distribution or abundance of marine mammals.

Pursuant to the MMPA, vessel noise during training and testing activities as described under Alternative 1 and Alternative 2 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, vessel noise during training and testing activities as described under Alternative 1 and Alternative 2 may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA. Vessel noise during training and testing activities would have no effect on designated critical habitat for the Southern Resident DPS of killer whale in the Inland Waters or on proposed critical habitat for the Southern Resident DPS of killer whale or for the Central America and Mexico DPSs of humpback whale in the Offshore Area.

3.4.2.1.4 Impacts from Aircraft Noise

Marine mammals may be exposed to aircraft-generated noise throughout the Study Area. Fixed- and rotary-wing aircraft are used for a variety of training and testing activities throughout the Study Area. Tilt-rotor impacts would be similar to fixed-wing or helicopter impacts depending which mode the aircraft is in. Most of these sounds would be concentrated around airbases and fixed ranges within each of the range complexes. Aircraft produce extensive airborne noise from either turbofan or turbojet engines. An infrequent type of aircraft noise is the sonic boom, produced when the aircraft exceeds the speed of sound. Rotary-wing aircraft produce low-frequency sound and vibration (Pepper et al., 2003). Section 3.4.2.1.1 (Background) summarizes and synthesizes available information on behavioral reactions, masking, and physiological stress due to noise exposure, including aircraft noise (Sections 3.4.2.1.1.2, Hearing Loss; 3.4.2.1.1.3, Physiological Stress; 3.4.2.1.1.4, Masking; and 3.4.2.1.1.5, Behavioral Reactions).

A detailed description of aircraft noise as a stressor is in Section 3.0.3.1.3 (Aircraft Noise). Activities may vary slightly from those previously analyzed in the 2015 NWTT Final EIS/OEIS, but the overall determinations presented remain valid. Increases and decreases shown in Tables 2.5-1, 2.5-2, and 2.5-3 for proposed training and testing activities under Alternative 1 and 2 do not appreciably change the impact conclusions presented in the 2015 NWTT Final EIS/OEIS.

Sound from naval aircraft during training and testing activities would overlap proposed critical habitat for the ESA-listed Central America and Mexico DPSs of humpback whales in the Offshore Area. As described in Section 3.4.1.13 (Humpback Whale [*Megaptera novaeangliae*]), one essential feature was identified for humpback whale critical habitat: prey species, primarily euphausiids and small pelagic schooling fishes, of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth. Although aircraft noise may elicit a brief response from individual prey species in close proximity to a low-flying aircraft, noise from aircraft during training and testing activities presents no plausible route of impact to prey species of sufficient quantity, abundance, and accessibility.

Sound from naval aircraft during training and testing activities would overlap ESA-listed Southern Resident DPS designated critical habitat in the Inland Waters and proposed critical habitat in the Offshore Area. Essential features for the conservation of the Southern Resident DPS critical habitat for the designated inland areas (National Marine Fisheries Service: Northwest Region, 2006) and proposed offshore areas include (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging. No adverse effects to any of these essential features are anticipated from exposure to aircraft noise.

- Noise from naval aircraft would not have a plausible route to affect the physical nature of water quality as defined under critical habitat.
- Although aircraft noise may elicit a brief response from individual prey species in close proximity to a low-flying aircraft (as discussed in Section 3.9.3.1.4 of the Fishes Chapter, Impacts from Aircraft Noise), noise from aircraft during training and testing activities presents no plausible route of impact to prey species of sufficient quantity, quality, and availability. The minor, infrequent contribution of aircraft noise to background noise would not chronically reduce effective foraging echolocation space in critical habitat. Number of events using aircraft are detailed in Tables 2.5-1, 2.5-2, and 2.5-3 for proposed training and testing activities under Alternative 1 and 2. See Section 3.0.3.1.3 (Aircraft Noise) for further information.
- Aircraft noise produced during training and testing activities would have no plausible route to obstruct waterways or impact the conservation function of passage conditions to allow for migration, resting, and foraging in designated or proposed critical habitat.

Under the No Action Alternative, the Navy would not conduct proposed at-sea training and testing activities in the Study Area. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities. Discontinuing the training and testing activities would result in fewer acoustic stressors (e.g., aircraft noise) within the marine environment where activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for impacts from aircraft noise on marine mammals, but would not measurably improve the overall distribution or abundance of marine mammals.

Pursuant to the MMPA, aircraft noise during training and testing activities as described under Alternative 1 and Alternative 2 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, aircraft noise during training and testing activities as described under Alternative 1 and Alternative 2 may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA. Aircraft noise during training and testing activities would have no effect on designated critical habitat for the Southern Resident DPS of killer whale in the Inland Waters or on proposed critical habitat for the Southern Resident DPS of killer whale or for the Central America and Mexico DPSs of humpback whale in the Offshore Area.

3.4.2.1.5 Impacts from Weapon Noise

Marine mammals may be exposed to sounds caused by the firing of weapons, objects in flight, and inert impact of non-explosive munitions on the water's surface, which are described in Section 3.0.3.1.4 (Weapons Noise). In general, these are impulsive sounds generated in close vicinity to or at the water surface, with the exception of items that are launched underwater. The firing of a weapon may have several components of associated noise. Firing of guns could include sound generated in air by firing a gun (muzzle blast) and a crack sound due to a low amplitude shock wave generated by a supersonic projectile flying through the air. Most in-air sound would be reflected at the air-water interface.

Underwater sounds would be strongest just below the surface and directly under the firing point. Any sound that enters the water only does so within a narrow cone below the firing point or path of the projectile. Vibration from the blast propagating through a ship's hull, the sound generated by the impact of an object with the water surface, and the sound generated by launching an object underwater are other sources of impulsive sound in the water. Sound due to missile and target launches is typically at a maximum at initiation of the booster rocket and rapidly fades as the missile or target travels downrange.

Section 3.4.2.2.1 (Background) summarizes and synthesizes available information on behavioral reactions, masking, and physiological stress due to impulsive noise exposure (Sections 3.4.2.1.1.2, Hearing Loss; 3.4.2.1.1.3, Physiological Stress; 3.4.2.1.1.4, Masking; and 3.4.2.1.1.5, Behavioral Reactions).

Activities may vary slightly from those previously analyzed in the 2015 NWTT Final EIS/OEIS, but the overall determinations presented remain valid. Increases and decreases shown in Tables 2.5-1, 2.5-2, and 2.5-3 for proposed training and testing activities under Alternative 1 and 2 do not appreciably change the impact conclusions presented in the 2015 NWTT Final EIS/OEIS. The Navy will implement mitigation measures to avoid or reduce potential impacts from weapon noise during large-caliber gunnery activities, as discussed in Section 5.3.2.2 (Weapons Firing Noise).

Weapon noise during training and testing activities would overlap proposed critical habitat for the ESA-listed Central America and Mexico DPSs of humpback whales in the Offshore Area, although implementation of the Marine Species Coastal and the Olympic Coast National Marine Sanctuary Mitigation Areas would limit any potential overlap of weapon noise with the proposed critical habitat in the Offshore Area during training and testing as described in Chapter 5 (Mitigation). As described in Section 3.4.1.13 (Humpback Whale [*Megaptera novaeangliae*]), one essential feature was identified for humpback whale critical habitat: prey species, primarily euphausiids and small pelagic schooling fishes, of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth. Weapons noise would not remove humpback prey items or reduce the quality of prey in terms of nutritional content.

Only weapons noise from small-caliber gunnery (using blanks) during training would overlap ESA-listed Southern Resident DPS designated critical habitat in the Inland Waters. Weapon noise during training and testing activities would overlap proposed critical habitat for the Southern Resident DPS in the Offshore Area, although implementation of the Marine Species Coastal and the Olympic Coast National Marine Sanctuary Mitigation Areas would limit any potential overlap of weapon noise with the proposed critical habitats in the Offshore Area during training and testing as described in Chapter 5 (Mitigation). Essential features for the conservation of the Southern Resident DPS critical habitat for the designated inland areas (National Marine Fisheries Service: Northwest Region, 2006) and the proposed offshore areas include (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging. None of these essential features would be adversely affected by weapon noise of the Proposed Action, as follows:

1. Weapon noise would not have a plausible route to affect the physical nature of water quality as defined under critical habitat.
2. Weapon noise would not remove prey items or reduce the quality of prey in terms of nutritional content.
3. Since weapon noise would be short in duration and would be generated a very limited number of times within any year, there would be no plausible route to obstruct waterways or impact the conservation function of passage conditions to allow for migration, resting, and foraging in designated critical habitat.

Under the No Action Alternative, the Navy would not conduct proposed at-sea training and testing activities in the Study Area. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities. Discontinuing the training and testing activities would result in fewer acoustic stressors (e.g., weapon noise) within the marine environment where activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would remove the potential for impacts from weapon noise on marine mammals, but would not measurably improve the overall distribution or abundance of marine mammals.

Pursuant to the MMPA, weapon noise during training and testing activities as described under Alternative 1 and Alternative 2 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, weapon noise during training and testing activities as described under Alternative 1 and Alternative 2 may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA. Weapon noise during training and testing activities would have no effect on designated critical habitat for the Southern Resident DPS of killer whale in the Inland Waters or on proposed critical habitat for the Southern Resident DPS of killer whale or for the Central America and Mexico DPSs of humpback whale in the Offshore Area.

3.4.2.2 Explosive Stressors

Assessing whether an explosive detonation may disturb or injure a marine mammal involves understanding the characteristics of the explosive sources, the marine mammals that may be present near the sources, the physiological effects of a close explosive exposure, and the effects of impulsive sound on marine mammal hearing and behavior. Many other factors besides just the received level or pressure wave of an explosion such as the animal's physical condition and size, prior experience with the explosive sound, and proximity to the explosion may influence physiological effects and behavioral reactions.

The ways in which an explosive exposure could result in immediate effects or lead to long-term consequences for an animal are explained in Section 3.0.3.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities). The following Background section discusses what is currently known about explosive effects to marine mammals.

Due to new acoustic impact criteria, marine mammal densities, and revisions to the Navy Acoustic Effects Model, the analysis provided in Section 3.4.2.2.2 (Impacts from Explosives) of this Supplemental supplants the 2015 NWTT Final EIS/OEIS for marine mammals and changes estimated impacts for some species since the 2015 NWTT Final EIS/OEIS.

3.4.2.2.1 Background

3.4.2.2.1.1 Injury

Injury refers to the direct effects on the tissues or organs of an animal due to exposure to pressure waves. Injury in marine mammals can be caused directly by exposure to explosions. Section 3.0.3.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities) provides additional information on injury and the framework used to analyze this potential impact.

Injury due to Explosives

Explosive injury to marine mammals would consist of primary blast injury, which refers to those injuries that result from the compression of a body exposed to a blast wave and is usually observed as barotrauma of gas-containing structures (e.g., lung and gut) and structural damage to the auditory system (Greaves et al., 1943; Office of the Surgeon General, 1991; Richmond et al., 1973). The near instantaneous high magnitude pressure change near an explosion can injure an animal where tissue material properties significantly differ from the surrounding environment, such as around air-filled cavities such as in the lungs or gastrointestinal tract. Large pressure changes at tissue-air interfaces in the lungs and gastrointestinal tract may cause tissue rupture, resulting in a range of injuries depending on degree of exposure. The lungs are typically the first site to show any damage, while the solid organs (e.g., liver, spleen, and kidney) are more resistant to blast injury (Clark & Ward, 1943). Recoverable injuries would include slight lung injury, such as capillary interstitial bleeding, and contusions to the gastrointestinal tract. More severe injuries, such as tissue lacerations, major hemorrhage, organ rupture, or air in the chest cavity (pneumothorax), would significantly reduce fitness and likely cause death in the wild. Rupture of the lung may also introduce air into the vascular system, producing air emboli that can cause a stroke or heart attack by restricting oxygen delivery to critical organs.

If an animal is exposed to an explosive blast underwater, the likelihood of injury depends on the charge size, the geometry of the exposure (distance to the charge, depth of the animal and the charge), and the size of the animal. In general, an animal would be less susceptible to injury near the water surface because the pressure wave reflected from the water surface would interfere with the direct path pressure wave, reducing positive pressure exposure. Susceptibility would increase with depth, until normal lung collapse (due to increasing hydrostatic pressure) and increasing ambient pressures again reduce susceptibility. See Appendix D (Acoustic and Explosives Concepts) for an overview of explosive propagation and an explanation of explosive effects on gas cavities.

The only known occurrence of mortality or injury to a marine mammal due to a Navy training or testing event involving explosives occurred in March 2011 in nearshore waters off San Diego, California, at the Silver Strand Training Complex. This area had been used for underwater demolitions training for at least three decades without prior known incident. On this occasion, however, a group of approximately 100–150 long-beaked common dolphins entered the mitigation zone surrounding an area where a time-delayed firing device had been initiated on an explosive with a net explosive weight of 8.76 pounds (lb.) (3.97 kilograms [kg]) placed at a depth of 48 ft. (14.6 m). Approximately one minute after detonation, three animals were observed dead at the surface. The Navy recovered those animals and transferred them to the local stranding network for necropsy. A fourth animal was discovered stranded and dead 42 NM to the north of the detonation three days later. It is unknown exactly how close those four animals were to the detonation. Upon necropsy, all four animals were found to have sustained typical mammalian primary blast injuries (Danil & St Leger, 2011). In the Pacific Northwest, there is no known occurrence of mortality or injury to marine mammals due to Navy training or testing events involving explosives.

Relatively little is known about auditory system trauma in marine mammals resulting from explosive exposure, although it is assumed that auditory structures would be vulnerable to blast injuries. Auditory trauma was found in two humpback whales that died following the detonation of a 5,000 kg explosive used off Newfoundland during demolition of an offshore oil rig platform (Ketten et al., 1993), but the proximity of the whales to the detonation was unknown. Eardrum rupture was examined in submerged terrestrial mammals exposed to underwater explosions (Richmond et al., 1973; Yelverton et al., 1973); however, results may not be applicable to the anatomical adaptations for underwater hearing in marine mammals. In this discussion, primary blast injury to auditory tissues is considered gross structural tissue damage distinct from TS or other auditory effects (see Section 3.4.2.2.1.2, Hearing Loss).

Controlled tests with a variety of lab animals (mice, rats, dogs, pigs, sheep and other species) are the best data sources on actual injury to mammals due to underwater exposure to explosions. In the early 1970s, the Lovelace Foundation for Medical Education and Research conducted a series of tests in an artificial pond at Kirtland Air Force Base, New Mexico, to determine the effects of underwater explosions on mammals, with the goal of determining safe ranges for human divers. The resulting data were summarized in two reports (Richmond et al., 1973; Yelverton et al., 1973). Specific physiological observations for each test animal are documented in Richmond et al. (1973). Gas-containing internal organs, such as lungs and intestines, were the principle damage sites in submerged terrestrial mammals; this is consistent with earlier studies of mammal exposures to underwater explosions in which lungs were consistently the first areas to show damage, with less consistent damage observed in the gastrointestinal tract (Clark & Ward, 1943; Greaves et al., 1943). Results from all of these tests suggest two explosive metrics are predictive of explosive injury: peak pressure and impulse.

Impulse as a Predictor of Explosive Injury

In the Lovelace studies, acoustic impulse was found to be the metric most related to degree of injury, and size of an animal's gas-containing cavities was thought to play a role in blast injury susceptibility. The lungs of most marine mammals are similar in proportion to overall body size as those of terrestrial mammals, so the magnitude of lung damage in the tests may approximate the magnitude of injury to marine mammals when scaled for body size. Within the marine mammals, mysticetes and deeper divers (e.g., Kogiidae, Physeteridae, Ziphiidae) tend to have lung to body size ratios that are smaller and more similar to terrestrial animal ratios than the shallow diving odontocetes (e.g., Phocoenidae, Delphinidae) and pinnipeds (Fahlman et al., 2014a; Piscitelli et al., 2010). The use of test data with smaller lung-to-body ratios to set injury thresholds may result in a more conservative estimate of potential for damaging effects (i.e., lower thresholds) for animals with larger lung-to-body ratios.

For these shallow exposures of small terrestrial mammals (masses ranging from 3.4 to 50 kg) to underwater detonations, Richmond et al. (1973) reported that no blast injuries were observed when exposures were less than 6 pounds per square inch per millisecond (psi-ms) (40 Pa-s), no instances of slight lung hemorrhage occurred below 20 psi-ms (140 Pa-s), and instances of no lung damage were observed in some exposures at higher levels up to 40 psi-ms (280 Pa-s). An impulse of 34 psi-ms (230 Pa-s) resulted in about 50 percent incidence of slight lung hemorrhage. About half of the animals had gastrointestinal tract contusions (with slight ulceration, i.e., some perforation of the mucosal layer) at exposures of 25-27 psi-ms (170-190 Pa-s). Lung injuries were found to be slightly more prevalent than gastrointestinal tract injuries for the same exposure.

The Lovelace subject animals were exposed near the water surface; therefore, depth effects were not discernible in this data set. In addition, this data set included only small terrestrial animals, whereas marine mammals may be several orders of magnitude larger and have respiratory structures adapted for the high pressures experienced at depth. The anatomical differences between the terrestrial animals used in the Lovelace tests and marine mammals are summarized in Fetherston et al. (2019). Goertner (1982) examined how lung cavity size would affect susceptibility to blast injury by considering both marine mammal size and depth in a bubble oscillation model of the lung; however, the Goertner (1982) model did not consider how tissues surrounding the respiratory air spaces would reflect shock wave energy or constrain oscillation (Fetherston et al., 2018). Animal depth relates to injury susceptibility in two ways: injury is related to the relative increase in explosive pressure over hydrostatic pressure, and lung collapse with depth reduces the potential for air cavity oscillatory damage. The period over which an impulse must be delivered to cause damage is assumed to be related to the natural oscillation period of an animal's lung, which depends on lung size.

Because gas-containing organs are more vulnerable to primary blast injury, adaptations for diving that allow for collapse of lung tissues with depth may make animals less vulnerable to lung injury with depth. Adaptations for diving include a flexible thoracic cavity, distensible veins that can fill space as air compresses, elastic lung tissue, and resilient tracheas with interlocking cartilaginous rings that provide strength and flexibility (Ridgway, 1972). Denk et al. (2020) found intra-species differences in the compliance of tracheobronchial structures of post-mortem cetaceans and pinnipeds under diving hydrostatic pressures, which would affect depth of alveolar collapse. Older literature suggested complete lung collapse depths at approximately 70 m for dolphins (Ridgway & Howard, 1979) and 20–50 m for phocid seals (Falke et al., 1985; Kooyman et al., 1972). Follow-on work by Kooyman and Sinnett (1982), in which pulmonary shunting was studied in harbor seals and sea lions, suggested that complete lung collapse for these species would be about 170 m and about 180 m, respectively. More recently, evidence in sea lions suggests that complete collapse might not occur until depths as great as 225 m; although the depth of collapse and depth of the dive are related, sea lions can affect the depth of lung collapse by varying the amount of air inhaled on a dive (McDonald & Ponganis, 2012). This is an important consideration for all divers who can modulate lung volume and gas exchange prior to diving via the degree of inhalation and during diving via exhalation (Fahlman et al., 2009); indeed, there are noted differences in pre-dive respiratory behavior, with some marine mammals exhibiting pre-dive exhalation to reduce the lung volume (e.g., phocid seals (Kooyman et al., 1973)).

Peak Pressure as a Predictor of Explosive Injury

High instantaneous peak pressures can cause damaging tissue distortion. Goertner (1982) suggested a peak overpressure gastrointestinal tract injury criterion because the size of gas bubbles in the gastrointestinal tract are variable, and their oscillation period could be short relative to primary blast wave exposure duration. The potential for gastrointestinal tract injury, therefore, may not be adequately modeled by the single oscillation bubble methodology used to estimate lung injury due to impulse. Like impulse, however, high instantaneous pressures may damage many parts of the body, but damage to the gastrointestinal tract is used as an indicator of any peak pressure-induced injury due to its vulnerability.

Older military reports documenting exposure of human divers to blast exposure generally describe peak pressure exposures around 100 psi (237 dB re 1 µPa peak) to feel like slight pressure or stinging sensation on skin, with no enduring effects (Christian & Gaspin, 1974). Around 200 psi, the shock wave felt like a blow to the head and chest. Data from the Lovelace Foundation experiments show instances of gastrointestinal tract contusions after exposures up to 1147 psi peak pressure, while exposures of up to 588 psi peak pressure resulted in many instances of no observed gastrointestinal tract effects. The lowest exposure for which slight contusions to the gastrointestinal tract were reported was 237 dB re 1 µPa peak. As a vulnerable gas-containing organ, the gastrointestinal tract is vulnerable to both high peak pressure and high impulse, which may vary to differing extents due to blast exposure conditions (i.e., animal depth, distance from the charge). This likely explains the range of effects seen at similar peak pressure exposure levels and shows the utility of considering both peak pressure and impulse when analyzing the potential for injury due to explosives.

3.4.2.2.1.2 Hearing Loss

Exposure to intense sound may result in noise-induced hearing loss that persists after cessation of the noise exposure. Hearing loss may be temporary or permanent, depending on factors such as the exposure frequency, received SPL, temporal pattern, and duration. The frequencies affected by hearing loss may vary depending on the exposure frequency, with frequencies at and above the exposure frequency most strongly affected. The amount of hearing loss may range from slight to profound, depending on the ability of the individual to hear at the affected frequencies. Section 3.0.3.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities) provides additional information on hearing loss and the framework used to analyze this potential impact.

Hearing loss has only been studied in a few species of marine mammals, although hearing studies with terrestrial mammals are also informative. There are no direct measurements of hearing loss in marine mammals due to exposure to explosive sources. The sound resulting from an explosive detonation is considered an impulsive sound and shares important qualities (i.e., short duration and fast rise time) with other impulsive sounds such as those produced by air guns. General research findings regarding TTS and PTS in marine mammals as well as findings specific to exposure to other impulsive sound sources are discussed in Section 3.4.2.1.1.2 (Hearing Loss) and Section 3.4.2.1.1.1 (Injury) under Acoustic Stressors above.

3.4.2.2.1.3 Physiological Stress

Marine mammals naturally experience stress within their environment and as part of their life histories. The stress response is a suite of physiological changes that are meant to help an organism mitigate the impact of a stressor. However, if the magnitude and duration of the stress response is too great or too long, then it can have negative consequences to the organism (e.g., decreased immune function, decreased reproduction). Section 3.0.3.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities) provides additional information on physiological stress and the framework used to analyze this potential impact.

There are no direct measurements of physiological stress in marine mammals due to exposure to explosive sources. General research findings regarding physiological stress in marine mammals due to exposure to sound and other stressors are discussed in detail in Section 3.4.2.1.1.3 (Physiological Stress) under Acoustic Stressors above. Because there are many unknowns regarding the occurrence of acoustically induced stress responses in marine mammals, it is assumed that any physiological response (e.g., hearing loss or injury) or significant behavioral response is also associated with a stress response.

3.4.2.2.1.4 Masking

Masking occurs when one sound, distinguished as the "noise," interferes with the detection, discrimination, or recognition of another sound. The quantitative definition of masking is the amount in decibels an auditory detection, discrimination, or recognition threshold is raised in the presence of a masker (Erbe et al., 2016). As discussed in Section 3.0.3.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities), masking can effectively limit the distance over which a marine mammal can communicate, detect biologically relevant sounds, and echolocate (odontocetes). Masking only occurs in the presence of the masking noise and does not persist after the cessation of the noise. Masking can lead to vocal changes (e.g., Lombard effect, increasing amplitude, or changing frequency) and behavior changes (e.g., cessation of foraging, leaving an area) to both signalers and receivers, in an attempt to compensate for noise levels (Erbe et al., 2016).

There are no direct observations of masking in marine mammals due to exposure to explosive sources. General research findings regarding masking in marine mammals due to exposure to sound and other stressors are discussed in detail in Section 3.4.2.1.1.4 (Masking) under Acoustic Stressors above. Potential masking from explosive sounds is likely to be similar to masking studied for other impulsive sounds such as air guns.

3.4.2.2.1.5 Behavioral Reactions

As discussed in Section 3.0.3.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities), any stimuli in the environment can cause a behavioral response in marine mammals, including noise from explosions. There are few direct observations of behavioral reactions from marine mammals due to exposure to explosive sounds. Lammers et al. (2017) recorded dolphin detections near naval mine neutralization exercises and found that although the immediate response (within 30 seconds of the explosion) was an increase in whistles relative to the 30 seconds before the explosion, there was a reduction in daytime acoustic activity during the day of and the day after the exercise within 6 km. However, the nighttime activity did not seem to be different than that prior to the exercise, and two days after there appeared to be an increase in daytime acoustic activity, indicating a rapid return to the area by the dolphins (Lammers et al. 2017). Vallejo et al. (2017) report on boat-based line-transect surveys which were run over 10 years in an area where an offshore wind farm was built; these surveys included the periods of preconstruction, construction, and postconstruction. Harbor porpoise were observed throughout the area during all three phases, but were not detected within the footprint of the windfarm during the construction phase, and were overall less frequent throughout the study area. However, they returned after the construction was completed at a slightly higher level than in the preconstruction phase. Furthermore, there was no large-scale displacement of harbor porpoises during construction, and in fact their avoidance behavior only occurred out to about 18 km, in contrast to the approximately 25 km avoidance distance found in other windfarm construction and pile driving monitoring efforts.

Impulsive signals, particularly at close range, have a rapid rise time and higher instantaneous peak pressure than other signal types, making them more likely to cause startle responses or avoidance responses. However, at long distances the rise time increases as the signal duration lengthens (similar to a "ringing" sound), making the impulsive signal more similar to a non-impulsive signal (Hastie et al., 2019; Martin et al., 2020). Behavioral reactions from explosive sounds are likely to be similar to reactions studied for other impulsive sounds, such as those produced by air guns and impact pile driving. Data on behavioral responses to impulsive sound sources are limited across all marine mammal groups, with only a few studies available for mysticetes and odontocetes. Most data have come from seismic surveys that occur over long durations (e.g., on the order of days to weeks), and typically utilize large multi-air gun arrays that fire repeatedly. While seismic data provide the best available science for assessing behavioral responses to impulsive sounds by marine mammals, it is likely that these responses represent a worst-case scenario compared to responses to explosives used in Navy activities, which would typically consist of single impulses or a cluster of impulses, rather than long-duration, repeated impulses. See Section 3.4.2.1.1.5 (Behavioral Reactions) under Section 3.4.2.1 (Acoustic Stressors) for a summary of information on marine mammal reactions to impulsive sounds.

3.4.2.2.1.6 Stranding

When a marine mammal (alive or dead) swims or floats onto shore and becomes beached or incapable of returning to sea, the event is termed a "stranding" (Geraci et al., 1999; Geraci & Lounsbury, 2005; Perrin & Geraci, 2002). Specifically, under U.S. law, a stranding is an event in the wild where "(A) a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance" (16 U.S.C. section 1421h).

Impulsive sources (e.g., explosions) also have the potential to contribute to strandings, but such occurrences are even less common than those that have been related to certain sonar activities. During a Navy training event on March 4, 2011, at the Silver Strand Training Complex in San Diego, California, three long-beaked common dolphins were killed by an underwater detonation. Further details are provided above. Discussions of mitigation measures associated with these and other training and testing events are presented in Chapter 5 (Mitigation).

3.4.2.2.1.7 Long-Term Consequences

Long-term consequences to a population are determined by examining changes in the population growth rate. For additional information on the determination of long-term consequences, see Section 3.0.3.7 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities). Physical effects from explosive sources that could lead to a reduction in the population growth rate include mortality or injury, which could remove animals from the reproductive pool, and permanent hearing impairment or chronic masking, which could impact navigation, foraging, predator avoidance, or communication. The long-term consequences due to individual behavioral reactions, masking and short-term instances of physiological stress are especially difficult to predict because individual experience over time can create complex contingencies, especially for long-lived animals like marine mammals. For example, a lost reproductive opportunity could be a measurable cost to the individual; however, short-term costs may be recouped during the life of an otherwise healthy individual. These factors are taken into consideration when assessing risk of long-term consequences.

3.4.2.2.2 Impacts from Explosives

Marine mammals could be exposed to energy, sound, and fragments from explosions in the water and near the water surface associated with the proposed activities. Energy from an explosion is capable of causing mortality, injury, hearing loss, a behavioral response, masking, or physiological stress, depending on the level and duration of exposure.

The death of an animal would eliminate future reproductive potential, which is considered in the analysis of potential long-term consequences to the population. Exposures that result in non-auditory injuries or PTS may limit an animal's ability to find food, communicate with other animals, or interpret the surrounding environment. Impairment of these abilities can decrease an individual's chance of survival or impact its ability to successfully reproduce. TTS can also impair an animal's abilities, but the individual is likely to recover quickly with little significant effect.

Explosions in the ocean or near the water surface can introduce loud, impulsive, broadband sounds into the marine environment. These sounds, which are within the audible range of most marine mammals, could cause behavioral reactions, masking and elevated physiological stress. Behavioral responses can include shorter surfacings, shorter dives, fewer blows (breaths) per surfacing, longer intervals between blows, ceasing or increasing vocalizations, shortening or lengthening vocalizations, and changing frequency or intensity of vocalizations (National Research Council 2005). Sounds from explosives could also mask biologically important sounds; however, the duration of individual sounds is very short, reducing the likelihood of substantial auditory masking.

3.4.2.2.2.1 Methods for Analyzing Impacts from Explosives

The Navy performed a quantitative analysis to estimate the number of times that marine mammals could be impacted by explosions used during Navy training and testing activities. The Navy's quantitative analysis to determine impacts on marine mammals uses the Navy Acoustic Effects Model to produce initial estimates of the number of instances that animals may experience these effects; these estimates are further refined by considering animal avoidance of sound-producing activities and implementation of procedural mitigation measures. The steps of this quantitative analysis are described in Section 3.0.1.2 (Navy's Quantitative Analysis to Determine Impacts to Sea Turtles and Marine Mammals), which takes into account:

- criteria and thresholds used to predict impacts from explosives (see below);
- the density (U.S. Department of the Navy, 2020) and spatial distribution (Watwood et al., 2018) of marine mammals; and
- the influence of environmental parameters (e.g., temperature, depth, salinity) on sound propagation and explosive energy when estimating the received sound level and pressure on the animals.

A detailed explanation of this analysis is provided in the technical report *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Department of the Navy, 2018c).

Criteria and Thresholds used to Estimate Impacts on Marine Mammals from Explosives

Mortality and Injury from Explosives

As discussed above in Section 3.4.2.1.1.1 (Injury), two metrics have been identified as predictive of injury: impulse and peak pressure. Peak pressure contributes to the "crack" or "stinging" sensation of a blast wave, compared to the "thump" associated with received impulse. Older military reports documenting exposure of human divers to blast exposure generally describe peak pressure exposures around 100 psi (237 dB re 1 µPa SPL peak) to feel like slight pressure or stinging sensation on skin, with no enduring effects (Christian & Gaspin, 1974).

Because data on explosive injury do not indicate a set threshold for injury, rather a range of risk for explosive exposures, two sets of criteria are provided for use in non-auditory injury assessment. The exposure thresholds are used to estimate the number of animals that may be affected during Navy training and testing activities (Table 3.4-69). The thresholds for the farthest range to effect are based on the received level at which 1 percent risk of onset is predicted and are useful for assessing potential effects to marine mammals and the level of potential impacts covered by the mitigation zones. Increasing animal mass and increasing animal depth both increase the impulse thresholds (i.e., decrease susceptibility), whereas smaller mass and decreased animal depth reduce the impulse thresholds (i.e., increase susceptibility). For impact assessment, marine mammal populations are assumed to be 70 percent adult and 30 percent calf/pup. Sub-adult masses are used to determine onset of effect, in order to estimate the farthest range at which an effect may first be observable. The derivation of these injury criteria and the species mass estimates are provided in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017b).

Table 3.4-69: Criteria to Quantitatively Assess Non-Auditory Injury Due to Underwater Explosions

Impact Category	*Impact Threshold*	*Threshold for Farthest Range to Effect*[2]
Mortality[1]	$144M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s	$103\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s
Injury[1]	$65.8M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s	$47.5M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s
	243 dB re 1 µPa SPL peak	237 dB re 1 µPa SPL peak

[1] Impulse delivered over 20 percent of the estimated lung resonance period. See U.S. Department of the Navy (2017a).

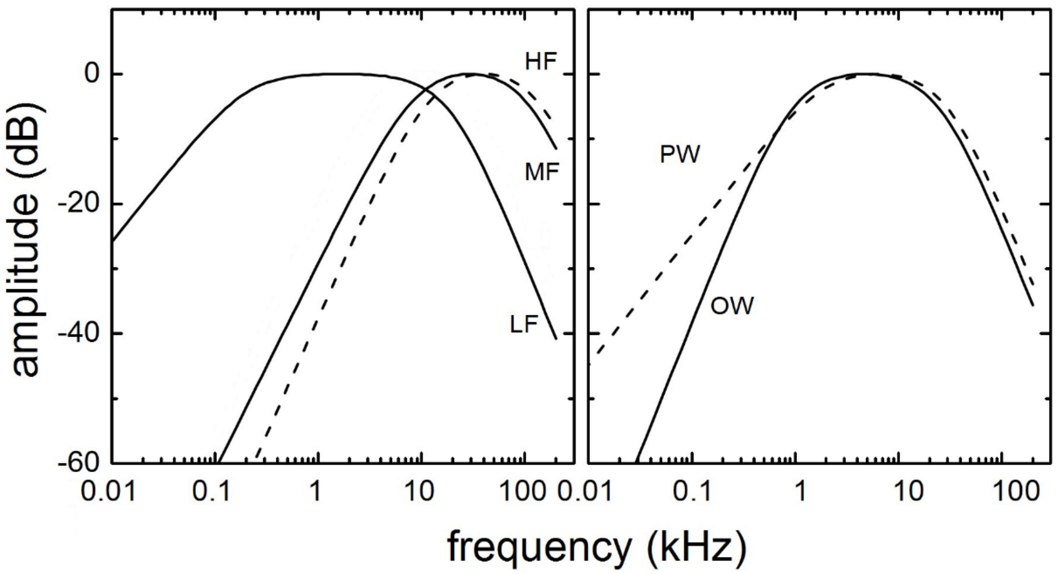
[2] Threshold for one percent risk used to assess mitigation effectiveness.

Notes: D = animal depth (m), dB re 1 µPa = decibels referenced to 1 micropascal, M = animal mass (kg), Pa-s = Pascal-second, SPL = sound pressure level

When explosive ordnance (e.g., bomb or missile) detonates, fragments of the weapon are thrown at high-velocity from the detonation point, which can injure or kill marine mammals if they are struck. Risk of fragment injury reduces exponentially with distance as the fragment density is reduced. Fragments underwater tend to be larger than fragments produced by in-air explosions (Swisdak & Montanaro, 1992). Underwater, the friction of the water would quickly slow these fragments to a point where they no longer pose a threat. On the other hand, the blast wave from an explosive detonation moves efficiently through the seawater. Because the ranges to mortality and injury due to exposure to the blast wave are likely to far exceed the zone where fragments could injure or kill an animal, the above thresholds are assumed to encompass risk due to fragmentation.

Auditory Weighting Functions

Animals are not equally sensitive to noise at all frequencies. To capture the frequency-dependent nature of the effects of noise, auditory weighting functions are used (Figure 3.4-68). Auditory weighting functions are mathematical functions based on a generic band-pass filter and incorporate species-specific hearing abilities to calculate a weighted received sound level in units SPL or SEL. Due to the band pass nature of auditory weighting functions, they resemble an inverted "U" shape with amplitude plotted as a function of frequency. The flatter portion of the plotted function, where the amplitude is closest to zero, is the emphasized frequency range (i.e., the pass-band), while the frequencies below and above this range (where amplitude declines) are de-emphasized.

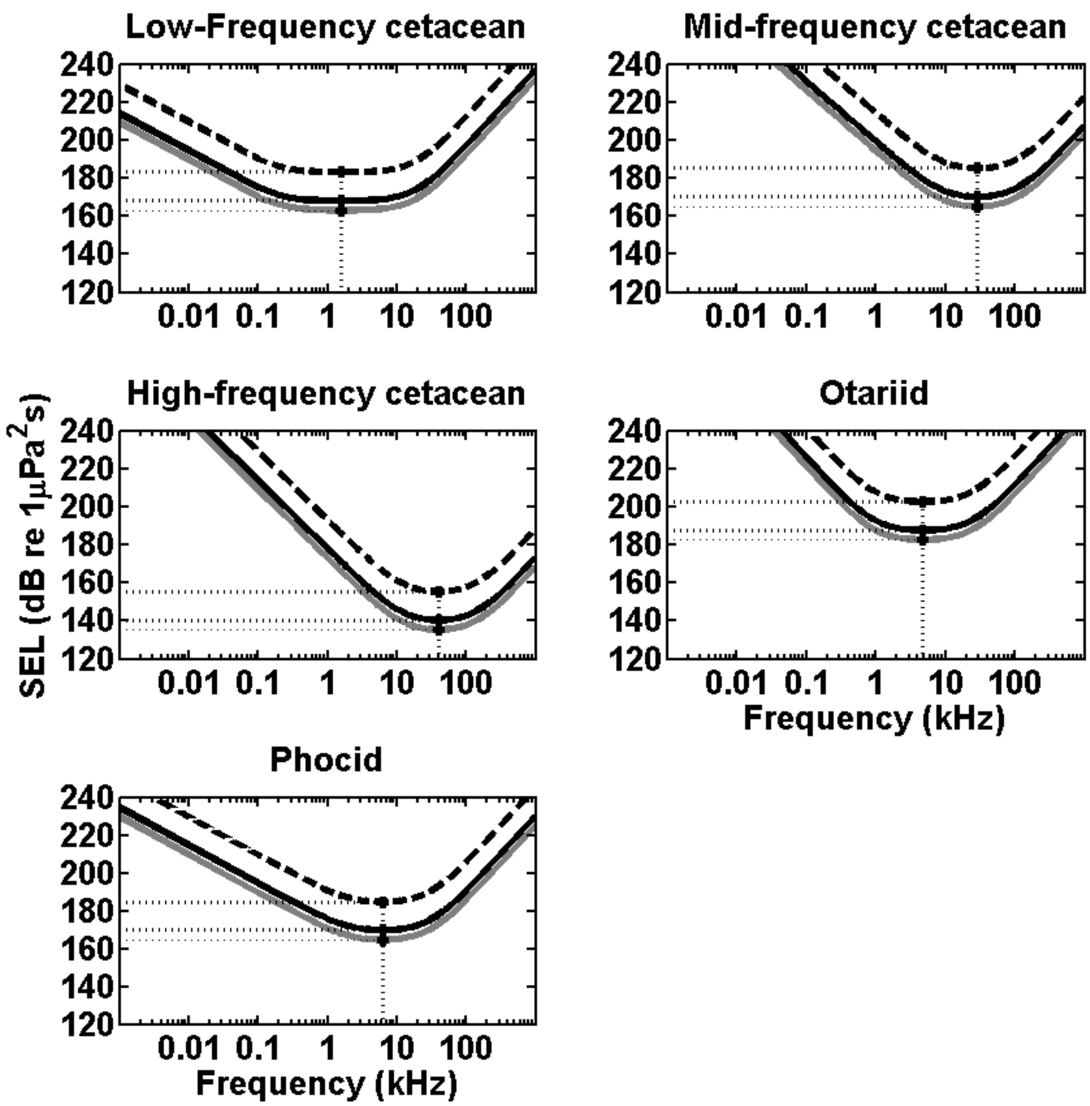


Source: See U.S. Department of the Navy (2017b) for parameters used to generate the functions and more information on weighting function derivation.
Notes: MF = mid-frequency cetacean, HF = high-frequency cetacean, LF = low-frequency cetacean, PW = phocid (in-water), and OW = otariid and other non-phocid marine carnivores (in-water)

Figure 3.4-68: Navy Phase III Weighting Functions for All Species Groups

Hearing Loss from Explosives

Criteria used to define TSs from explosions are derived from the two known studies designed to induce TTS in marine mammals from impulsive sources. Finneran et al. (2002) reported behaviorally measured TTS of 6 and 7 dB in a beluga exposed to single impulses from a seismic water gun and Lucke et al. (2009) reported auditory evoked potential-measured TTS of 7 to 20 dB in a harbor porpoise exposed to single impulses from a seismic air gun. Since marine mammal PTS data from impulsive noise exposures do not exist, onset-PTS levels for all groups were estimated by adding 15 dB to the threshold for non-impulsive sources. This relationship was derived by Southall et al. (2007) from impulsive noise TTS growth rates in chinchillas. These frequency dependent thresholds are depicted by the exposure functions for each group's range of best hearing (Figure 3.4-69). Weighted sound exposure thresholds for underwater explosive sounds used in the analysis are shown in Table 3.4-70).



Notes: The dark dashed curve is the exposure function for PTS onset, the solid black curve is the exposure function for TTS onset, and the light grey curve is the exposure function for behavioral response. Small dashed lines indicate the SEL threshold for behavioral response, TTS, and PTS onset at each group's most sensitive frequency (i.e., the weighted SEL threshold).

Figure 3.4-69: Navy Phase III Behavioral, TTS and PTS Exposure Functions for Explosives

Table 3.4-70: Navy Phase III Weighted Sound Exposure Thresholds for Underwater Explosive Sounds

Hearing Group	*Explosive Sound Source*				
	Behavior (SEL) weighted (dB)	*TTS (SEL) weighted (dB)*	*TTS (Peak SPL) unweighted (dB)*	*PTS (SEL) weighted (dB)*	*PTS (Peak SPL) unweighted (dB)*
Low-frequency Cetacean (LF)	163	168	213	183	219
Mid-frequency Cetacean (MF)	165	170	224	185	230
High-frequency Cetacean (HF)	135	140	196	155	202
Otariids[1] in water (OW)	183	188	226	203	232
Phocid seal in water (PW)	165	170	212	185	218

Notes: dB = decibels, PTS = permanent threshold shift, SEL = sound exposure level, SPL = sound pressure level, and TTS = temporary threshold shift.
[1]Threshold shift for mustelids (sea otters) is assessed using the otariid sound exposure thresholds. Any behavioral reactions by sea otters are assumed to occur within the TTS threshold.

Behavioral Responses from Explosives

Marine mammals may be exposed to isolated impulses in their natural environment (e.g., lightning). For single explosions at received sound levels below hearing loss thresholds, the most likely behavioral response is a brief alerting or orienting response; therefore, the analysis assumes that any modeled instance of temporally or spatially separated detonations occurring in a single 24-hour period could result in harassment under the MMPA for military readiness activities within the range to TTS. Some multiple explosive exercises, such as certain naval gunnery exercises, may be treated as a single event because a few explosions occur closely spaced within a very short time (a few seconds). Since no further sounds follow the initial brief impulses, significant behavioral reactions would not be expected to occur. This reasoning was applied to previous shock trials (63 FR 230; 66 FR 87; 73 FR 143) and is extended to the criteria used in this analysis.

If more than one explosive event occurs within any given 24-hour period within a training or testing activity, criteria are applied to predict the number of animals that may have a behavioral reaction at a behavioral threshold 5 dB less than the TTS onset threshold (in SEL). This value is derived from observed onsets of behavioral response by test subjects (bottlenose dolphins) during non-impulsive TTS testing (Schlundt et al., 2000).

Although there is no research on the effects of explosives on sea otter behavior, based on their low reactivity to other acoustic and anthropogenic stressors, sea otters exposed to received levels below the threshold for TTS are assumed to be unlikely to exhibit behavioral responses that would be considered "harassment" under the MMPA for military readiness activities, if behavioral reactions to distant sounds occur at all.

Accounting for Mitigation

The Navy will implement mitigation measures to avoid or reduce potential impacts from explosives on marine mammals, as described in Section 5.3.3 (Explosive Stressors). The benefits of mitigation are conservatively factored into the analysis for Alternative 1 and Alternative 2 of the Proposed Action for training and testing. The Navy's mitigation measures are identical for both action alternatives.

Procedural mitigation measures include delaying or ceasing applicable detonations when a marine mammal is observed in a mitigation zone. The mitigation zones for explosives extend beyond the respective average ranges to mortality. Therefore, the impact analysis considers the potential for procedural mitigation to reduce the risk of mortality due to exposure to explosives. Two factors are considered when quantifying the effectiveness of mitigation: (1) the extent to which the type of mitigation proposed for a sound-producing activity (e.g., an explosive activity) allows for observation of the mitigation zone prior to and during the activity; and (2) the sightability of each species that may be present in the mitigation zone, which is determined by species-specific characteristics and the viewing platform. A detailed explanation of the analysis is provided in the technical report *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Department of the Navy, 2018c).

The impact analysis does not analyze the potential for mitigation to reduce non-auditory injury, PTS, TTS, or behavioral effects, even though mitigation would also reduce the likelihood of these effects. In practice, mitigation also protects all unobserved (below the surface) animals in the vicinity, including other species, in addition to the observed animal. However, the analysis assumes that only animals sighted at the water surface would be protected by the applied mitigation. The analysis, therefore, does not capture the protection afforded to all marine species that may be near or within the mitigation zone.

The ability to observe the ranges to mortality was estimated for each training or testing event. The ability of Navy Lookouts to detect marine mammals within a mitigation zone is dependent on the animal's presence at the surface and the characteristics of the animal that influence its sightability (such as group size or surface active behavior). The behaviors and characteristics of some species may make them easier to detect. Certain behaviors, such as leaping and breaching, are visible from a great distance and likely increase sighting distances and detections of those species. Environmental conditions under which the training or testing activity could take place are also considered, such as sea surface conditions, weather (e.g., fog or rain), and day versus night.

The Navy will also implement mitigation measures for certain explosive activities within mitigation areas, as described in Appendix K (Geographic Mitigation Assessment). Mitigation areas are designed to help avoid or reduce impacts during biologically important life processes within particularly important habitat areas. The benefits of mitigation areas are discussed qualitatively in terms of the context of impact avoidance or reduction.

3.4.2.2.2.2 Impact Ranges for Explosives

The following section provides the range (distance) over which specific physiological or behavioral effects are expected to occur based on the explosive criteria and the explosive propagation calculations from the Navy Acoustic Effects Model (Section 3.4.2.2.2.1, Methods for Analyzing Impacts from Explosives). The range to effects are shown for a range of explosive bins, from E1 (up to 0.25 lb. net explosive weight) to E11 (greater than 500 lb. to 650 lb. net explosive weight). In the below tables, only E3 charges would be used in both Inland Waters and in the Offshore Area. All ranges are for conditions in the Offshore Area except where indicated for E3 in the Inland Waters. Ranges are determined by modeling the distance that noise from an explosion will need to propagate to reach exposure level thresholds specific to a hearing group that will cause behavioral response, TTS, PTS, and non-auditory injury. Range to effects is important information in not only predicting impacts from explosives, but also in verifying the accuracy of model results against real-world situations and assessing the level of impact that will likely be mitigated within applicable mitigation zones.

Table 3.4-71 shows the minimum, average, and maximum ranges due to varying propagation conditions to non-auditory injury as a function of animal mass and explosive bin. Ranges to gastrointestinal tract injury typically exceed ranges to slight lung injury; therefore, the maximum range to effect is not mass-dependent. Animals within these water volumes would be expected to receive minor injuries at the outer ranges, increasing to more substantial injuries, and finally mortality as an animal approaches the detonation point. Ranges to mortality, based on animal mass, are shown in Table 3.4-72.

Table 3.4-71: Ranges to Non-Auditory Injury (in meters) for All Marine Mammal Hearing Groups

Bin[2]	*Range to Non-Auditory Injury (meters)* [1]
E1	12 (11–13)
E2	16 (15–16)
E3	25 (25–45)
E4	31 (23–50)
E5	40 (40–40)
E7	104 (80–190)
E8	149 (130–210)
E10	153 (100–400)
E11	419 (350–725)

[1]Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.
Notes: Modeled ranges based on peak pressure for a single explosion generally exceed the modeled ranges based on impulse (related to animal mass and depth).
[2]Bin (net explosive weight, lb.): E1 (0.1–0.25), E2 (> 0.25–0.5), E3 (> 0.5–2.5), E4 (> 2.5–5), E5 (> 5–10), E7 (> 20–60), E8 (> 60–100), E10 (> 250–500), E11 (> 500–650)

Table 3.4-72: Ranges to Mortality (in meters) for All Marine Mammal Hearing Groups as a Function of Animal Mass

Bin[2]	*Range to Mortality (meters) for Various Animal Mass Intervals (kg)*[1]					
	10 kg	***250 kg***	***1,000 kg***	***5,000 kg***	***25,000 kg***	***72,000 kg***
E1	3 (2–3)	1 (0–3)	0 (0 –0)	0 (0 –0)	0 (0–0)	0 (0–0)
E2	4 (3–5)	2 (1–3)	1 (0–1)	0 (0–0)	0 (0–0)	0 (0–0)
E3	10 (9–20)	5 (3–20)	2 (1–5)	0 (0–3)	0 (0–1)	0 (0–1)
E4	13 (11–19)	7 (4–13)	3 (2–4)	2 (1–3)	1 (1–1)	1 (0–1)
E5	13 (11–15)	7 (4–11)	3 (3–4)	2 (1–3)	1 (1–1)	1 (0–1)
E7	49 (40–80)	27 (15–60)	13 (10–20)	9 (5–12)	4 (4–6)	3 (2–4)
E8	65 (60–75)	34 (22–55)	17 (14–20)	11 (9–13)	6 (5–6)	5 (4–5)
E10	43 (40–50)	25 (16–40)	13 (11–16)	9 (7–11)	5 (4–6)	4 (3–4)
E11	185 (90–230)	90 (30–170)	40 (30–50)	28 (23–30)	15 (13–16)	11 (9–13)

[1]Average distance to mortality (meters) is depicted above the minimum and maximum distances, which are in parentheses for each animal mass interval.
[2]Bin (net explosive weight, lb.): E1 (0.1–0.25), E2 (> 0.25–0.5), E3 (> 0.5–2.5), E4 (> 2.5–5), E5 (> 5–10), E7 (> 20–60), E8 (> 60–100), E10 (> 250–500), E11 (> 500–650)
Notes: kg = kilogram

The following tables (Table 3.4-73 through Table 3.4-82) show the minimum, average, and maximum ranges to onset of auditory and behavioral effects based on the thresholds described in Section 3.4.2.2.2.1 (Methods for Analyzing Impacts from Explosives) are provided for a representative source depth and cluster size (the number of rounds fired [or buoys dropped] within a very short duration) for each bin. For events with multiple explosions, sound from successive explosions can be expected to accumulate and increase the range to the onset of an impact based on SEL thresholds. Modeled ranges to TTS and PTS based on peak pressure for a single explosion generally exceed the modeled ranges based on SEL even when accumulated for multiple explosions. Peak pressure-based ranges are estimated using the best available science; however, data on peak pressure at far distances from explosions are very limited. For additional information on how ranges to impacts from explosions were estimated, see the technical report *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing Ranges* (U.S. Department of the Navy, 2018c).

Table 3.4-73: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction (in meters) for High-Frequency Cetaceans

Range to Effects for Explosives: High-Frequency Cetaceans[1]					
Bin[2]	***Source Depth (meters)***	***Cluster Size***	***Range to PTS (meters)***	***Range to TTS (meters)***	***Range to Behavioral (meters)***
E1	0.1	1	361 (350–370)	1,108 (1,000–1,275)	1,515 (1,025–2,025)
		18	1,002 (925–1,025)	2,404 (1,275–4,025)	3,053 (1,275–5,025)
E2	0.1	1	439 (420–450)	1,280 (1,025–1,775)	1,729 (1,025–2,525)
		5	826 (775–875)	1,953 (1,275–3,025)	2,560 (1,275–4,275)
E3	10 (Inland Waters)	1	1,647 (160–3,525)	2,942 (160–10,275)	3,232 (160–12,275)
	18.25	1	684 (550–1,000)	2,583 (1,025–5,025)	4,217 (1,525–7,525)
		12	1,774 (1,025–3,775)	5,643 (1,775–10,025)	7,220 (2,025–13,275)
E4	10	2	1,390 (950–3,025)	5,250 (2,275–8,275)	7,004 (2,775–11,275)
	30	2	1,437 (925–2,775)	4,481 (1,525–7,775)	5,872 (2,775–10,525)
	70	2	1,304 (925–2,275)	3,845 (2,525–7,775)	5,272 (3,525–9,525)
	90	2	1,534 (900–2,525)	5,115 (2,525–7,525)	6,840 (3,275–10,275)
E5	0.1	1	940 (850–1,025)	2,159 (1,275–3,275)	2,762 (1,275–4,275)
		20	1,930 (1,275–2,775)	4,281 (1,775–6,525)	5,176 (2,025–7,775)
E7	10	1	2,536 (1,275–3,775)	6,817 (2,775–11,025)	8,963 (3,525–14,275)
	30	1	1,916 (1,025–4,275)	5,784 (2,775–10,525)	7,346 (2,775–12,025)
E8	45.75	1	1,938 (1,275–4,025)	4,919 (1,775–11,275)	5,965 (2,025–15,525)
E10	0.1	1	1,829 (1,025–2,775)	4,166 (1,775–6,025)	5,023 (2,025–7,525)

Table 3.4-73: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction (in meters) for High-Frequency Cetaceans (continued)

Range to Effects for Explosives: High-Frequency Cetaceans[1]					
Bin[2]	*Source Depth (meters)*	*Cluster Size*	*Range to PTS (meters)*	*Range to TTS (meters)*	*Range to Behavioral (meters)*
E11	91.4	1	3,245 (2,025–6,775)	6,459 (2,525–15,275)	7,632 (2,775–19,025)
	200	1	3,745 (3,025–5,025)	7,116 (4,275–11,275)	8,727 (5,025–15,025)

[1]Average distance (meters) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances (due to varying propagation environments), which are in parentheses.
[2]Bin (net explosive weight, lb.): E1 (0.1–0.25), E2 (> 0.25–0.5), E3 (> 0.5–2.5), E4 (> 2.5–5), E5 (> 5–10), E7 (> 20–60), E8 (> 60–100), E10 (> 250–500), E11 (> 500–650)
Notes: PTS = permanent threshold shift, SEL = sound exposure level, TTS = temporary threshold shift

Table 3.4-74: Peak Pressure Based Ranges to Onset PTS and Onset TTS (in meters) for High-Frequency Cetaceans

Range to Effects for Explosives: High-Frequency Cetaceans[1]			
Bin[2]	***Source Depth (meters)***	***Range to PTS (meters)***	***Range to TTS (meters)***
E1	0.1	713 (625–800)	1,018 (775–1,275)
E2	0.1	833 (700–1,000)	1,151 (850–1,525)
E3	10 (Inland Waters)	2,229 (160–6,025)	2,994 (160–9,775)
	18.25	2,030 (1,275–5,775)	2,982 (1,275–6,775)
E4	10	2,990 (1,275–5,775)	5,338 (2,275–10,025)
	30	2,321 (1,525–4,025)	4,064 (2,275–7,525)
	70	3,100 (1,775–4,525)	4,731 (3,525–6,525)
	90	3,046 (2,025–4,525)	4,850 (2,775–8,275)
E5	0.1	1,508 (1,000–2,275)	2,078 (1,025–3,525)
E7	10	6,747 (3,275–12,025)	10,248 (4,275–20,525)
	30	6,159 (3,025–9,275)	10,175 (4,775–17,275)
E8	45.75	4,661 (1,775–18,775)	10,961 (1,775–47,025)
E10	0.1	2,880 (1,275–4,775)	3,807 (1,775–12,775)
E11	91.4	16,639 (2,525–49,275)	39,992 (6,525–97,775)
	200	13,555 (4,275–42,775)	45,123 (39,525–88,775)

[1]Average distance (meters) is shown with the minimum and maximum distances due to varying propagation environments in parentheses.
[2]Bin (net explosive weight, lb.): E1 (0.1–0.25), E2 (> 0.25–0.5), E3 (> 0.5–2.5), E4 (> 2.5–5), E5 (> 5–10), E7 (> 20–60), E8 (> 60–100), E10 (> 250–500), E11 (> 500–650)
Notes: PTS = permanent threshold shift, TTS = temporary threshold shift

Table 3.4-75: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction (in meters) for Low-Frequency Cetaceans

Range to Effects for Explosives: Low-Frequency Cetaceans[1]					
Bin[2]	*Source Depth (meters)*	*Cluster Size*	*Range to PTS (meters)*	*Range to TTS (meters)*	*Range to Behavioral (meters)*
E1	0.1	1	52 (50–55)	221 (120–250)	354 (160–420)
		18	177 (110–200)	656 (230–875)	836 (280–1,025)
E2	0.1	1	66 (55–70)	276 (140–320)	432 (180–525)
		5	128 (90–140)	512 (200–650)	735 (250–975)
E3	10 (Inland Waters)	1	330 (160–550)	1,583 (160–4,025)	2,085 (160–7,525)
	18.25	1	198 (180–220)	1,019 (490–2,275)	1,715 (625–4,025)
		12	646 (390–1,025)	3,723 (800–9,025)	6,399 (1,025–46,525)
E4	10	2	462 (400–600)	3,743 (2,025–7,025)	6,292 (2,525–13,275)
	30	2	527 (330–950)	3,253 (1,775–4,775)	5,540 (2,275–8,275)
	70	2	490 (380–775)	3,026 (1,525–4,775)	5,274 (2,275–7,775)
	90	2	401 (360–500)	3,041 (1,275–4,525)	5,399 (1,775–9,275)
E5	0.1	1	174 (100–260)	633 (220–850)	865 (270–1,275)
		20	550 (200–700)	1,352 (420–2,275)	2,036 (700–4,275)
E7	10	1	1,375 (875–2,525)	7,724 (3,025–15,025)	11,787 (4,525–25,275)
	30	1	1,334 (675–2,025)	7,258 (2,775–11,025)	11,644 (4,525–24,275)
E8	45.75	1	1,227 (575–2,525)	3,921 (1,025–17,275)	7,961 (1,275–48,525)
E10	0.1	1	546 (200–700)	1,522 (440–5,275)	3,234 (850–30,525)
E11	91.4	1	2,537 (950–5,525)	11,249 (1,775–50,775)	37,926 (6,025–94,775)
	200	1	2,541 (1,525–4,775)	7,407 (2,275–43,275)	42,916 (6,275–51,275)

[1]Average distance (meters) is shown with the minimum and maximum distances due to varying propagation environments in parentheses. Values depict the range produced by SEL hearing threshold criteria levels.
[2]Bin (net explosive weight, lb.): E1 (0.1–0.25), E2 (> 0.25–0.5), E3 (> 0.5–2.5), E4 (> 2.5–5), E5 (> 5–10), E7 (> 20–60), E8 (> 60–100), E10 (> 250–500), E11 (> 500–650)
Notes: PTS = permanent threshold shift, SEL = sound exposure level, TTS = temporary threshold shift

Table 3.4-76: Peak Pressure Based Ranges to Onset PTS and Onset TTS (in meters) for Low-Frequency Cetaceans

Range to Effects for Explosives: Low-Frequency Cetaceans[1]			
Bin[2]	***Source Depth (meters)***	***Range to PTS (meters)***	***Range to TTS (meters)***
E1	0.1	133 (90–150)	234 (110–270)
E2	0.1	165 (100–180)	288 (120–340)
E3	10 (Inland Waters)	450 (160–1,000)	907 (160–3,275)
	18.25	355 (260–825)	664 (390–1,775)
E4	10	402 (370–430)	833 (650–1,275)
	30	582 (300–975)	938 (470–2,025)
	70	571 (370–1,275)	891 (550–1,775)
	90	437 (370–750)	933 (650–1,525)
E5	0.1	410 (150–500)	683 (210–900)
E7	10	1,121 (750–2,025)	2,248 (1,025–4,775)
	30	1,307 (525–2,275)	1,829 (775–3,775)
E8	45.75	1,486 (575–3,525)	2,130 (800–5,775)
E10	0.1	925 (280–1,275)	1,243 (350–1,775)
E11	91.4	2,845 (950–7,525)	3,662 (1,025–9,025)
	200	3,284 (1,525–6,025)	4,586 (1,775–8,275)

[1]Average distance (meters) is shown with the minimum and maximum distances due to varying propagation environments in parentheses.
[2]Bin (net explosive weight, lb.): E1 (0.1–0.25), E2 (> 0.25 – 0.5), E3 (> 0.5–2.5), E4 (> 2.5–5), E5 (> 5–10), E7 (> 20–60), E8 (> 60–100), E10 (> 250–500), E11 (> 500–650)
Notes: PTS = permanent threshold shift, TTS = temporary threshold shift

Table 3.4-77: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction (in meters) for Mid-Frequency Cetaceans

Range to Effects for Explosives: Mid-Frequency Cetaceans[1]					
Bin[2]	*Source Depth (meters)*	*Cluster Size*	*Range to PTS (meters)*	*Range to TTS (meters)*	*Range to Behavioral (meters)*
E1	0.1	1	25 (25–25)	118 (110–120)	203 (190–210)
		18	96 (90–100)	430 (410–440)	676 (600–700)
E2	0.1	1	30 (30–30)	146 (140–150)	246 (230–250)
		5	64 (60–65)	298 (290–300)	493 (470–500)
E3	10 (Inland Waters)	1	61 (50–100)	512 (160–750)	928 (160–2,025)
	18.25	1	40 (35–40)	199 (180–280)	368 (310–800)
		12	127 (120–130)	709 (575–1,000)	1,122 (875–2,525)
E4	10	2	73 (70–75)	445 (400–575)	765 (600–1,275)
	30	2	71 (65–90)	554 (320–1,025)	850 (525–1,775)
	70	2	63 (60–85)	382 (320–675)	815 (525–1,275)
	90	2	59 (55–85)	411 (310–900)	870 (525–1,275)
E5	0.1	1	79 (75–80)	360 (350–370)	575 (525–600)
		20	295 (280–300)	979 (800–1,275)	1,442 (925–1,775)
E7	10	1	121 (110–130)	742 (575–1,275)	1,272 (875–2,275)
	30	1	111 (100–130)	826 (500–1,775)	1,327 (925–2,275)
E8	45.75	1	133 (120–170)	817 (575–1,525)	1,298 (925–2,525)
E10	0.1	1	273 (260–280)	956 (775–1,025)	1,370 (900–1,775)
E11	91.4	1	242 (220–310)	1,547 (1,025–3,025)	2,387 (1,275–4,025)
	200	1	209 (200–300)	1,424 (1,025–2,025)	2,354 (1,525–3,775)

[1]Average distance (meters) is shown with the minimum and maximum distances due to varying propagation environments in parentheses.
[2]Bin (net explosive weight, lb.): E1 (0.1–0.25), E2 (> 0.25–0.5), E3 (> 0.5–2.5), E4 (> 2.5–5), E5 (> 5–10), E7 (> 20–60), E8 (> 60–100), E10 (> 250–500), E11 (> 500–650)
Notes: PTS = permanent threshold shift, SEL = sound exposure level, TTS = temporary threshold shift

Table 3.4-78: Peak Pressure Based Ranges to Onset PTS and Onset TTS (in meters) for Mid-Frequency Cetaceans

Range to Effects for Explosives: Mid-Frequency Cetaceans[1]			
Bin[2]	***Source Depth (meters)***	***Range to PTS (meters)***	***Range to TTS (meters)***
E1	0.1	44 (40–45)	86 (80–90)
E2	0.1	59 (55–60)	106 (100–110)
E3	10 (Inland Waters)	122 (100–230)	245 (160–410)
	18.25	100 (100–100)	190 (180–280)
E4	10	120 (120–120)	247 (240–260)
	30	136 (120–220)	365 (230–750)
	70	129 (120–200)	257 (230–440)
	90	126 (120–190)	247 (230–380)
E5	0.1	160 (150–170)	295 (280–300)
E7	10	309 (300–370)	592 (525–825)
	30	483 (290–850)	840 (525–1,775)
E8	45.75	561 (350–1,025)	1,056 (625–2,275)
E10	0.1	557 (490–600)	878 (625–1,025)
E11	91.4	1,187 (650–2,525)	2,272 (1,025–4,275)
	200	683 (650–950)	1,972 (1,025–4,025)

[1]Average distance (meters) is shown with the minimum and maximum distances due to varying propagation environments in parentheses.
[2]Bin (net explosive weight, lb.): E1 (0.1–0.25), E2 (> 0.25–0.5), E3 (> 0.5–2.5), E4 (> 2.5–5), E5 (> 5–10), E7 (> 20 – 60), E8 (> 60–100), E10 (> 250–500), E11 (> 500–650)
Notes: PTS = permanent threshold shift, TTS = temporary threshold shift

Table 3.4-79: SEL Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction (in meters) for Otariids and Mustelids

Range to Effects for Explosives: Otariids and Mustelids[1]					
Bin[2]	***Source Depth (meters)***	***Cluster Size***	**Range to *PTS (meters)***	**Range to *TTS (meters)***	**Range to *Behavioral (meters)***
E1	0.1	1	7 (7–8)	34 (30–35)	58 (55–60)
		18	25 (25–25)	124 (120–130)	208 (200–210)
E2	0.1	1	9 (9–10)	43 (40–45)	72 (70–75)
		5	19 (19–20)	88 (85–90)	145 (140–150)
E3	10 (Inland Waters)	1	21 (18–25)	135 (120–210)	250 (160–370)
	18.25	1	15 (15–15)	91 (85–95)	155 (150–160)
		12	53 (50–55)	293 (260–430)	528 (420–825)
E4	10	2	30 (30–30)	175 (170–180)	312 (300–350)
	30	2	25 (25–25)	176 (160–250)	400 (290–750)
	70	2	26 (25–35)	148 (140–200)	291 (250–400)
	90	2	26 (25–35)	139 (130–190)	271 (250–360)
E5	0.1	1	25 (24–25)	111 (110–120)	188 (180–190)
		20	93 (90–95)	421 (390–440)	629 (550–725)
E7	10	1	60 (60–60)	318 (300–360)	575 (500–775)
	30	1	53 (50–65)	376 (290–700)	742 (500–1,025)
E8	45.75	1	55 (55–55)	387 (310–750)	763 (525–1,275)
E10	0.1	1	87 (85–90)	397 (370–410)	599 (525–675)
E11	91.4	1	100 (100–100)	775 (550–1,275)	1,531 (900–3,025)
	200	1	94 (90–100)	554 (525–700)	1,146 (900–1,525)

[1]Average distance (meters) is shown with the minimum and maximum distances due to varying propagation environments in parentheses.
[2]Bin (net explosive weight, lb.): E1 (0.1–0.25), E2 (> 0.25–0.5), E3 (> 0.5–2.5), E4 (> 2.5–5), E5 (> 5–10), E7 (> 20–60), E8 (> 60–100), E10 (> 250–500), E11 (> 500–650)
Notes: PTS = permanent threshold shift, SEL = sound exposure level, TTS = temporary threshold shift

Table 3.4-80: Peak Pressure Based Ranges to Onset PTS and Onset TTS (in meters) for Otariids and Mustelids

Range to Effects for Explosives: Otariids and Mustelids[1]			
Bin[2]	***Source Depth (meters)***	***Range to PTS (meters)***	***Range to TTS (meters)***
E1	0.1	37 (35–40)	69 (65–70)
E2	0.1	48 (45–50)	88 (80–90)
E3	10 (Inland Waters)	99 (85–170)	197 (150–370)
	18.25	80 (80–85)	154 (150–200)
E4	10	100 (100–100)	190 (190–190)
	30	105 (100–140)	262 (190–675)
	70	106 (100–160)	206 (190–350)
	90	103 (100–150)	197 (190–320)
E5	0.1	128 (120–130)	243 (230–250)
E7	10	255 (250–260)	471 (440–500)
	30	419 (240–1,025)	722 (440–1,025)
E8	45.75	434 (280–975)	913 (525–2,025)
E10	0.1	476 (450–490)	739 (600–875)
E11	91.4	934 (525–1,775)	1,912 (1,000–3,775)
	200	553 (525–800)	1,516 (1,000–3,525)

[1]Average distance (meters) is shown with the minimum and maximum distances due to varying propagation environments in parentheses.
[2]Bin (net explosive weight, lb.): E1 (0.1–0.25), E2 (> 0.25–0.5), E3 (> 0.5–2.5), E4 (> 2.5–5), E5 (> 5–10), E7 (> 20– 60), E8 (> 60–100), E10 (> 250–500), E11 (> 500–650)
Notes: PTS = permanent threshold shift, TTS = temporary threshold shift

Table 3.4-81: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction (in meters) for Phocids

Range to Effects for Explosives: Phocids[1]					
Bin[2]	***Source Depth (meters)***	***Cluster Size***	***Range to PTS (meters)***	***Range to TTS (meters)***	***Range to Behavioral (meters)***
E1	0.1	1	47 (45–50)	219 (210–230)	366 (350–370)
		18	171 (160–180)	764 (725–800)	1,088 (1,025–1,275)
E2	0.1	1	59 (55–60)	273 (260–280)	454 (440–460)
		5	118 (110–120)	547 (525–550)	881 (825–925)
E3	10 (Inland Waters)	1	185 (160–260)	1,144 (160–2,775)	1,655 (160–4,525)
	18.25	1	112 (110–120)	628 (500–950)	1,138 (875–2,525)
		12	389 (330–625)	2,248 (1,275–4,275)	4,630 (1,275–8,525)
E4	10	2	226 (220–240)	1,622 (950–3,275)	3,087 (1,775–5,775)
	30	2	276 (200–600)	1,451 (1,025–2,275)	2,611 (1,775–4,275)
	70	2	201 (180–280)	1,331 (1,025–1,775)	2,403 (1,525–3,525)
	90	2	188 (170–270)	1,389 (975–2,025)	2,617 (1,775–3,775)
E5	0.1	1	151 (140–160)	685 (650–700)	1,002 (950–1,025)
		20	563 (550–575)	1,838 (1,275–2,275)	2,588 (1,525–3,525)
E7	10	1	405 (370–490)	3,185 (1,775–6,025)	5,314 (2,275–11,025)
	30	1	517 (370–875)	2,740 (1,775–4,275)	4,685 (3,025–7,275)
E8	45.75	1	523 (390–1,025)	2,502 (1,525–6,025)	3,879 (2,025–10,275)
E10	0.1	1	522 (500–525)	1,800 (1,275–2,275)	2,470 (1,525–3,275)
E11	91.4	1	1,063 (675–2,275)	5,043 (2,775–10,525)	7,371 (3,275–18,025)
	200	1	734 (675–850)	5,266 (3,525–9,025)	7,344 (5,025–12,775)

[1]Average distance (meters) is shown with the minimum and maximum distances due to varying propagation environments in parentheses.
[2]Bin (net explosive weight, lb.): E1 (0.1–0.25), E2 (> 0.25–0.5), E3 (> 0.5–2.5), E4 (> 2.5–5), E5 (> 5–10), E7 (> 20–60), E8 (> 60–100), E10 (> 250–500), E11 (> 500–650)
Notes: PTS = permanent threshold shift, SEL = sound exposure level, TTS = temporary threshold shift

Table 3.4-82: Peak Pressure Based Ranges to Onset PTS and Onset TTS (in meters) for Phocids

Range to Effects for Explosives: Phocids[1]			
Bin[2]	***Source Depth (meters)***	***Range to PTS (meters)***	***Range to TTS (meters)***
E1	0.1	156 (140–160)	291 (270–300)
E2	0.1	198 (190–200)	366 (350–370)
E3	10 (Inland Waters)	582 (160–1,775)	975 (160–2,525)
	18.25	398 (330–700)	795 (600–1,775)
E4	10	456 (430–490)	940 (750–1,775)
	30	700 (430–1,025)	1,111 (825–2,025)
	70	645 (420–1,275)	1,085 (750–1,775)
	90	557 (420–875)	1,082 (750–1,775)
E5	0.1	538 (525–550)	936 (850–1,000)
E7	10	1,241 (875–2,025)	2,571 (1,275–5,775)
	30	1,495 (900–2,275)	2,185 (1,275–3,775)
E8	45.75	1,919 (1,025–4,025)	3,206 (1,775–7,275)
E10	0.1	1,469 (1,025–1,775)	2,244 (1,275–3,025)
E11	91.4	4,277 (2,525–9,275)	6,965 (3,025–13,775)
	200	4,388 (2,775–7,025)	6,853 (4,275–12,775)

[1]Average distance (meters) is shown with the minimum and maximum distances due to varying propagation environments in parentheses.
[2]Bin (net explosive weight, lb.): E1 (0.1–0.25), E2 (> 0.25–0.5), E3 (> 0.5–2.5), E4 (> 2.5–5), E5 (> 5–10), E7 (> 20–60), E8 (> 60–100), E10 (> 250–500), E11 (> 500–650)
Notes: PTS = permanent threshold shift, TTS = temporary threshold shift

3.4.2.2.2.3 Impacts from Explosives Under the Action Alternatives

The following provides a brief description of training and testing as it pertains to underwater and near-surface explosions under the action alternatives:

As described in Chapter 2 (Description of Proposed Action and Alternatives), training activities under Alternative 1 would use underwater detonations and explosive ordnance. The number and type (i.e., source bin) of explosives that would be detonated in the water for each training activity and the location in the Study Area are provided in Table 2.5-1 (Proposed Training Activities). Table 3.0-7 (Explosive Sources Quantitatively Analyzed that Could Be Used Underwater or at the Water Surface) in Section 3.0.3.2.1.1 (Explosions in Water) shows the total number of explosives in each bin (i.e., range of net explosive weight) that are proposed for use for training annually. Within Alternative 1, most training activities that use explosives reoccur on an annual basis, with some variability year-to-year. To avoid or reduce potential impacts from explosive training activities on marine species, the Navy will not conduct explosive training activities within 50 NM from shore in the Marine Species Coastal Mitigation Area, and will only use explosives at the Hood Canal Explosive Ordnance Disposal (EOD) Range and Crescent Harbor EOD Range during explosive mine neutralization activities involving the use of Navy divers. Navy event planners will coordinate with Navy biologists during the event planning process prior to conducting explosive mine neutralization activities involving the use of Navy divers (for Southern Resident killer whales). Navy biologists will work with NMFS and will initiate communication with the appropriate marine mammal detection networks to determine the likelihood of Southern Resident killer whale presence in the planned training location. Navy biologists will notify event planners of the likelihood of species presence. To the maximum extent practicable, Navy planners will use this information when planning specific details of the event (e.g., timing, location, duration) to avoid planning activities in locations or seasons where Southern Resident killer whale presence is expected. The Navy will ensure environmental awareness of event participants. Environmental awareness will help alert participating crews to the possible presence of applicable species in the training location. Lookouts will use the information to assist visual observation of applicable mitigation zones and to aid in the implementation of procedural mitigation.

As described in Chapter 2 (Description of Proposed Action and Alternatives), testing activities under Alternative 1 would use underwater detonations and explosive ordnance. The number and type (i.e., source bin) of explosives that would be detonated in the water for each testing activity and the location in the Study Area are provided in Table 2.5-2 (Current and Proposed Naval Sea Systems Command Testing Activities) and Table 2.5-3, (Current and Proposed Naval Air Systems Command Proposed Activities). Table 3.0-7 (Explosive Sources Quantitatively Analyzed that Could Be Used Underwater or at the Water Surface) in Section 3.0.3.2.1.1 (Explosions in Water) shows the total number of explosives in each bin (i.e., range of net explosive weight) that are proposed for use for testing annually. Within Alternative 1, most testing activities that use explosives reoccur on an annual basis. All testing involving explosives will occur in the Offshore Area. To avoid or reduce potential impacts from explosive testing activities on marine mammals, the Navy will not conduct any explosive testing activities in NWTT Inland Waters, and will not conduct explosive testing within 50 NM from shore in the Marine Species Coastal Mitigation Area, except explosive Mine Countermeasures and Neutralization Testing activities. Mine Countermeasure and Neutralization Testing is a new testing activity that would occur closer to shore than other in-water explosive activities analyzed in the 2015 NWTT Final EIS/OEIS for the Offshore Area. During this activity, explosives in bin E4 and bin E7 would be used greater than 3 NM and 6 NM, respectively, from shore in the Quinault Range Site and greater than 12 NM from shore off Washington and Oregon in the Offshore Area. These activities involving explosives would occur approximately two times per year and typically in water depths shallower than 1,000 ft. To avoid or reduce potential impacts on marine mammals, the Navy will not conduct explosive Mine Countermeasures and Neutralization Testing activities year-round in the Olympic Coast National Marine Sanctuary Mitigation Area, from May 1 to November 30 in the Stonewall and Heceta Bank Humpback Whale Mitigation Area, from July 1 to November 30 in the Point St. George Humpback Whale Mitigation Area, and year-round in the Juan de Fuca Eddy Marine Species Mitigation Area. Additionally, to the maximum extent practical, the Navy will conduct explosive Mine Countermeasure and Neutralization Testing from July 1 through September 30 when operating within 20 NM from shore in the Marine Species Coastal Mitigation Area. From October 1 through June 30, the Navy will conduct a maximum of one explosive Mine Countermeasure and Neutralization Testing event, not to exceed the use of 20 explosives from bin E4 and 3 explosives from bin E7 annually, and not to exceed the use of 60 explosives from bin E4 and 9 explosives from bin E7 over 7 years.

Within 50 NM from shore in the Marine Species Coastal Mitigation Area, the Navy will issue annual seasonal awareness notification messages to alert ships and aircraft to the possible presence of increased seasonal concentrations of humpback whales, gray whales, and Southern Resident killer whales. To avoid interactions with large whales, the Navy will instruct vessels to remain vigilant to the presence of these species, which may be vulnerable to potential impacts from training and testing activities. Platforms will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation.

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.5-1, and Section 3.0.3.2 (Explosive Stressors), training activities under Alternative 2 would use underwater detonations and explosive ordnance. Within Alternative 2, most training activities that use explosives reoccur on an annual basis, with the same number of exercises planned each year. Training activities involving explosives would be concentrated in the NWTT Offshore Area. Detonations would generally occur greater than 50 NM from shore, with the exception of a very small amount of mine neutralization training activities that would occur in existing mine warfare areas in Inland Waters (i.e., Crescent Harbor and Hood Canal Explosive Ordnance Disposal Training Ranges).

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.5-2 and Table 2.5-3, and Section 3.0.3.2 (Explosive Stressors), testing activities with explosives is identical under Alternative 1 and Alternative 2; therefore, the locations, types, and severity of predicted impacts would be the same.

Presentation of Estimated Impacts from the Quantitative Analysis

The results of the analysis of potential impacts on marine mammals from explosives (see above Section 3.4.2.2.2.1, Methods for Analyzing Impacts from Explosives) are discussed below. The numbers of potential impacts estimated for individual species of marine mammals from exposure to explosive energy and sound for training activities under Alternative 1 and 2 are shown in Appendix E (Estimated Marine Mammal and Sea Turtle Impacts from Exposure to Acoustic and Explosive Stressors Under Navy Training and Testing Activities). Additionally, estimated numbers of potential impacts from the quantitative analysis for each species are presented below (e.g., Figure 3.4-70). The most likely regions and activity categories from which the impacts could occur are displayed in the graphics for each species. There is a potential for impacts to occur anywhere within the Study Area where sound and energy from explosives and the species overlap, although only regions or activity categories where 0.5 percent of the impacts, or greater, are estimated to occur are graphically represented on the graphics below. All (i.e., grand total) estimated impacts are also included, regardless of region or category.

The predictions of numbers of marine mammals that may be affected are shown for the three subdivisions of the NWTT Study Area: the Offshore Area, Inland Waters, and Western Behm Canal (Southeast Alaska). The Inland Waters area has been further divided into the following sub-regions: Dabob Bay Range Complex (which includes the Hood Canal EOD Training Range) and Northeast Puget Sound (which includes the Crescent Harbor EOD Training Range).

The numbers of activities planned under Alternative 1 can vary slightly from year-to-year. Alternative 1 results are presented for a maximum explosive use year; however, during most years, explosive use would be less, resulting in fewer potential impacts. The numbers of activities planned under Alternative 2 are consistent from year-to-year. The numbers of explosives used under each alternative are described in Section 3.0.3.2 (Explosive Stressors).

Mysticetes

Mysticetes may be exposed to sound and energy from explosions associated with training and testing activities throughout the year. Explosions produce sounds that are within the hearing range of mysticetes (see Section 3.4.1.6, Hearing and Vocalization). Potential impacts from explosive energy and sound include non-auditory injury, behavioral reactions, physiological stress, masking, and hearing loss. The quantitative analysis estimates TTS and PTS in mysticetes. Impact ranges for mysticetes exposed to explosive sound and energy are discussed under low-frequency cetaceans in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Mysticetes that do experience TS from explosive sounds may have reduced ability to detect biologically important sounds (e.g., social vocalizations) until their hearing recovers. Recovery from TS begins almost immediately after the noise exposure ceases and can take a few minutes to a few days, depending on the severity of the initial shift, to recover. TTS would recover fully and PTS would leave some residual hearing loss. Threshold shifts do not necessarily affect all hearing frequencies equally, and typically manifest themselves at the exposure frequency or within an octave above the exposure frequency. Noise from explosions is broadband with most energy below a few hundred Hertz; therefore, any hearing loss from exposure to explosive sounds is likely to be broadband with effects predominantly at lower frequencies. During the short period that a mysticete had TTS, or permanently for PTS, social calls from conspecifics could be more difficult to detect or interpret, the ability to detect predators may be reduced, and the ability to detect and avoid sounds from approaching vessels or other stressors might be reduced. It is unclear how or if mysticetes use sound for finding prey or feeding; therefore, it is unknown whether a TTS would affect a mysticete’s ability to locate prey or rate of feeding.

Research and observations of auditory masking in marine mammals due to impulsive sounds are discussed in Section 3.4.2.2.1.4 (Masking). Explosions introduce low-frequency, broadband sounds into the environment, which could mask hearing thresholds in mysticetes that are nearby, although sounds from explosions last for only a few seconds at most. Masking due to time-isolated detonations would not be significant. Activities that have multiple detonations such as some naval gunfire exercises could create some masking for mysticetes in the area over the short duration of the event. Potential costs to mysticetes from masking are similar to those discussed above for TTS, with the primary difference being that the effects of masking are only present when the sound from the explosion is present within the water and the effect is over the moment the sound has ceased.

Research and observations (see Behavioral Responses from Explosives) show that if mysticetes are exposed to impulsive sounds such as those from explosives, they may react in a variety of ways, which may include alerting, startling, breaking off feeding dives and surfacing, diving or swimming away, changing vocalization, or showing no response at all. Overall, mysticetes have been observed to be more reactive to acoustic disturbance when a noise sources is located directly on their migration route. Mysticetes disturbed while migrating could pause their migration or route around the disturbance. Animals disturbed while engaged in other activities such as feeding or reproductive behaviors may be more likely to ignore or tolerate the disturbance and continue their natural behavior patterns. Because noise from most activities using explosives is short-term and intermittent, and because detonations usually occur within a small area, behavioral reactions from mysticetes are likely to be short-term and low to moderate severity, although there are no estimated behavioral impacts to mysticetes.

Physiological stress could be caused by injury or hearing loss and could accompany any behavioral reaction as well. Research and observations of physiological stress in marine mammals are discussed in Section 3.4.2.2.1.3 (Physiological Stress). Due to the short-term and intermittent use of explosives, physiological stress is also likely to be short-term and intermittent. Long-term consequences from physiological stress due to the sound of explosives would not be expected.

North Pacific Right Whales (Endangered Species Act-Listed)

Impacts from Explosives Under Alternative 1 for Training Activities

North Pacific right whales are extremely rare in the Study Area. North Pacific right whales could be present in the Offshore Area portion of the Study Area, but there is no evidence to indicate the presence of North Pacific right whales in the Inland Waters portion. Data on right whale presence is insufficient to develop density estimates for use in the Navy Acoustic Effects Model for estimating the number of animals that may be exposed to explosives.

Based on the highly unlikely presence of North Pacific right whales in the offshore portion of the Study Area and no records of occurrence in the Inland Waters portion of the Study Area, in addition to the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), exposure of any North Pacific right whales to explosives associated with training activities is highly unlikely.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of North Pacific right whales.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 1 may affect ESA-listed North Pacific right whales. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Explosives Under Alternative 1 for Testing Activities

North Pacific right whales are extremely rare in the Study Area. Data on right whale presence is insufficient to develop density estimates for use in the Navy Acoustic Effects Model for estimating the number of animals that may be exposed to explosives. With the exception of a small number of explosive Mine Countermeasure and Neutralization Testing activities, all explosive use in the Offshore portion of the Study Area would occur greater than 50 NM from shore.

Based on the highly unlikely presence of North Pacific right whales in the offshore portion of the Study Area, in addition to the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), exposure of any North Pacific right whales to explosives associated with testing activities is highly unlikely.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 would not result in the incidental taking of North Pacific right whales.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 1 may affect ESA-listed North Pacific right whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Impacts from Explosives Under Alternative 2 for Training Activities

North Pacific right whales are extremely rare in the Study Area. North Pacific right whales could be present in the Offshore Area portion of the Study Area, but there is no evidence to indicate the presence of North Pacific right whales in the Inland Waters portion. Data on right whale presence is insufficient to develop density estimates for use in the Navy Acoustic Effects Model for estimating the number of animals that may be exposed to explosives.

Based on the highly unlikely presence of North Pacific right whales in the offshore portion of the Study Area and no records of occurrence in the Inland Waters portion of the Study Area, in addition to the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), exposure of any North Pacific right whales to explosives associated with training activities is highly unlikely.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of North Pacific right whales.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 2 may affect ESA-listed North Pacific right whales.

Impacts from Explosives Under Alternative 2 for Testing Activities

North Pacific right whales are extremely rare in the Study Area. Data on right whale presence is insufficient to develop density estimates for use in the Navy Acoustic Effects Model for estimating the number of animals that may be exposed to explosives. With the exception of a small number of explosive Mine Countermeasure and Neutralization Testing activities, all explosive use in the Offshore portion of the Study Area would occur greater than 50 NM from shore.

Based on the highly unlikely presence of North Pacific right whales in the offshore portion of the Study Area, in addition to the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), exposure of any North Pacific right whales to explosives associated with testing activities is highly unlikely.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 would not result in the incidental taking of North Pacific right whales.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 2 may affect ESA-listed North Pacific right whales.

Blue Whales (Endangered Species Act-Listed)

Impacts from Explosives Under Alternative 1 for Training Activities

Blue whales may be exposed to sound or energy from explosions associated with training activities throughout the year. Blue whales could be present in the Offshore Area portion of the Study Area, but are not expected to occur in the Inland Waters portion. The quantitative analysis, using the maximum number of explosives per year under Alternative 1, estimates no impacts for training activities. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of blue whales.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 1 may affect ESA-listed blue whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

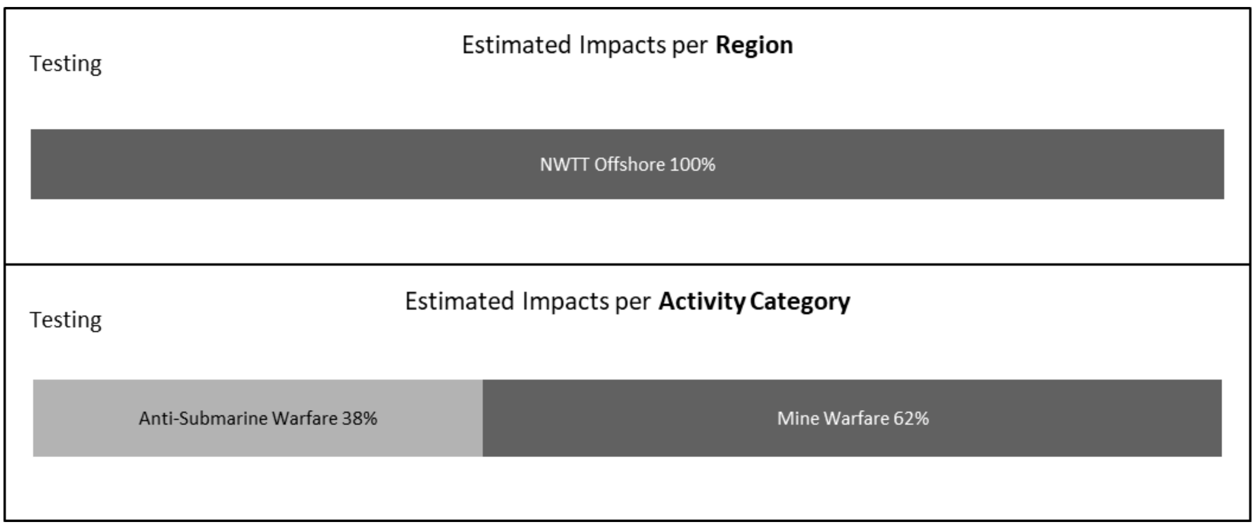
Impacts from Explosives Under Alternative 1 for Testing Activities

Blue whales present in the Offshore Area portion of the Study Area may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosives per year under Alternative 1, estimates behavioral reactions (Figure 3.4-70 and Table 3.4-83). Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to the Eastern North Pacific stock (Table 3.4-83).

As described for mysticetes above, even a few minor to moderate behavioral impacts to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of blue whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 1 may affect ESA-listed blue whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.



Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-70: Blue Whale Impacts Estimated per Year from the Maximum Number of Explosions During Testing Under Alternative 1 and Alternative 2

Table 3.4-83: Estimated Impacts on Individual Blue Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1 and Alternative 2

Estimated Impacts by Effect								
Stock	***Training***				***Testing***			
	Behavioral	***TTS***	***PTS***	***Injury***	***Behavioral***	***TTS***	***PTS***	***Injury***
Eastern North Pacific	0	0	0	0	1	0	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1 and Alternative 2.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of blue whales.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 2 would may affect ESA-listed blue whales.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities (see Figure 3.4-70 and Table 3.4-83).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of blue whales incidental to those activities.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 2 may affect ESA-listed blue whales.

Fin Whales (Endangered Species Act-Listed)

Impacts from Explosives Under Alternative 1 for Training Activities

Fin whales may be exposed to sound or energy from explosions associated with training activities throughout the year. Fin whales could be present year round in the Offshore Area but are not expected to occur in the Inland Waters portion of the Study Area. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training activities. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of fin whales.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 1 may affect ESA-listed fin whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

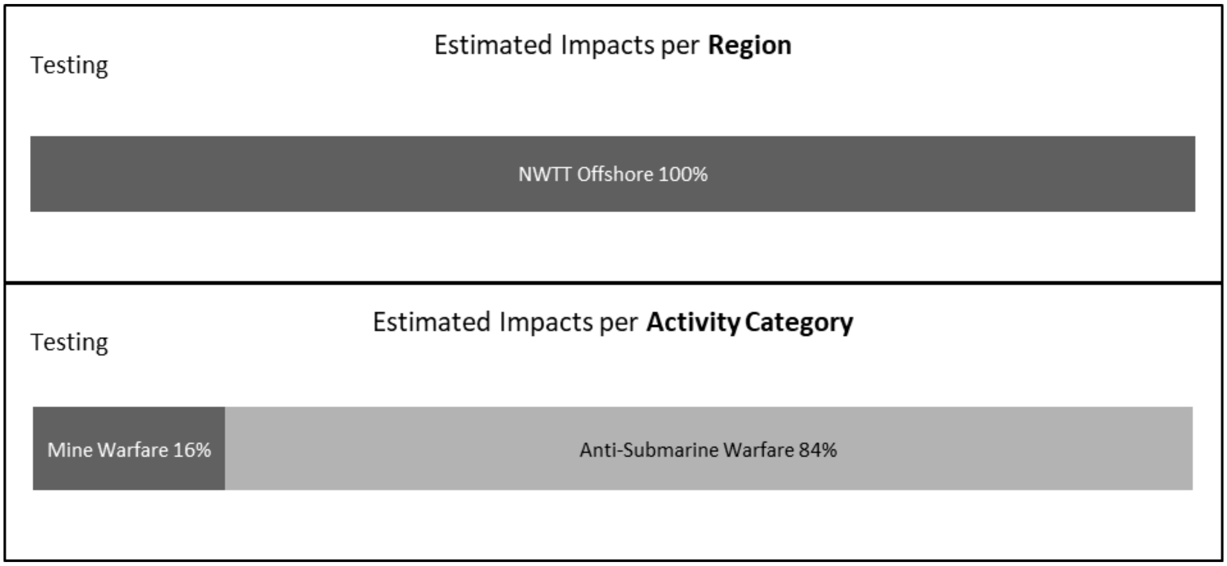
Impacts from Explosives Under Alternative 1 for Testing Activities

Fin whales present in the Offshore Area portion of the Study Area may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates behavioral reactions and TTS (Figure 3.4-71 and Table 3.4-84). Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to California, Oregon, and Washington stock (Table 3.4-84).

As described for mysticetes above, even a few minor to moderate behavioral responses or TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of fin whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 1 may affect ESA-listed fin whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.



Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-71: Fin Whale Impacts Estimated per Year from the Maximum Number of Explosions During Testing Under Alternative 1 and Alternative 2

Table 3.4-84: Estimated Impacts on Individual Fin Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1 and Alternative 2

Estimated Impacts by Effect								
Stock	***Training***				***Testing***			
	Behavioral	***TTS***	***PTS***	***Injury***	***Behavioral***	***TTS***	***PTS***	***Injury***
California, Oregon, & Washington	0	0	0	0	6	2	0	0
Northeast Pacific	0	0	0	0	0	0	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1 and Alternative 2.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of fin whales.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 2 may affect ESA-listed fin whales.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities (see Figure 3.4-71 and Table 3.4-84).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of fin whales incidental to those activities.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 2 may affect ESA-listed fin whales.

Sei Whales (Endangered Species Act-Listed)

Impacts from Explosives Under Alternative 1 for Training Activities

Sei whales may be exposed to sound or energy from explosions associated with training activities throughout the year. Sei whales could be present year round in the Offshore Area, but are not expected to occur in the Inland Waters portion of the Study Area. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of sei whales.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 1 may affect ESA-listed sei whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

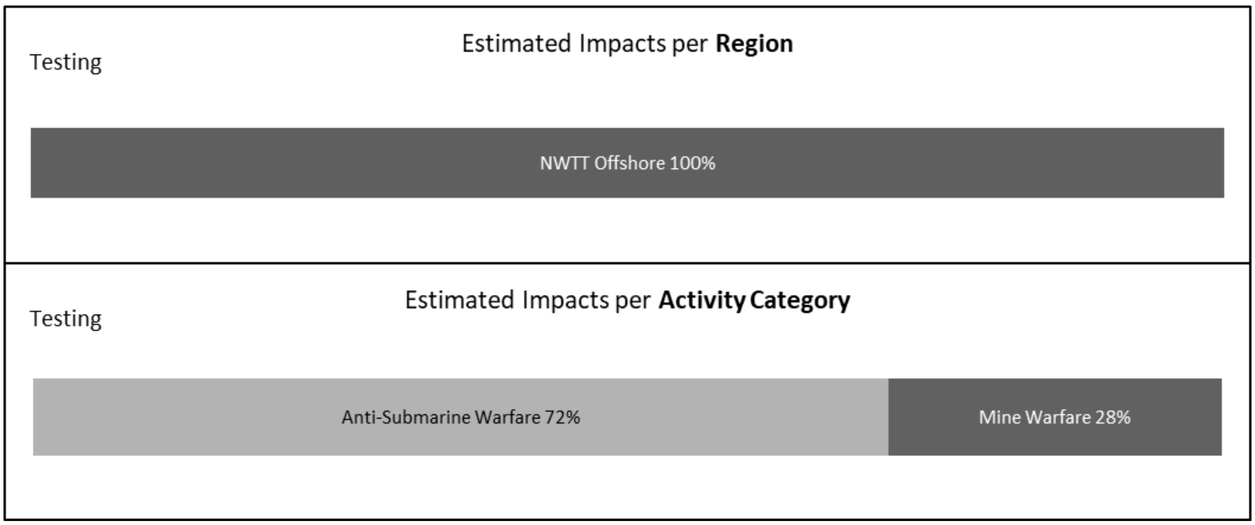
Impacts from Explosives Under Alternative 1 for Testing Activities

Sei whales present in the Offshore Area portion of the Study Area may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates behavioral reactions and TTS (Figure 3.4-72 and Table 3.4-85). Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to the Eastern North Pacific stock (Table 3.4-85).

As described for mysticetes above, even a few minor to moderate behavioral responses or TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of sei whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 1 may affect ESA-listed sei whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.



Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-72: Sei Whale Impacts Estimated per Year from the Maximum Number of Explosions During Testing Under Alternative 1 and Alternative 2

Table 3.4-85: Estimated Impacts on Individual Sei Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1 and Alternative 2

Estimated Impacts by Effect								
Stock	*Training*				*Testing*			
	Behavioral	***TTS***	***PTS***	***Injury***	***Behavioral***	***TTS***	***PTS***	***Injury***
Eastern North Pacific	0	0	0	0	1	1	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1 and Alternative 2.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of sei whales.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 2 may affect ESA-listed sei whales.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities (see Figure 3.4-72 and Table 3.4-85).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of sei whales incidental to those activities.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 2 may affect ESA-listed sei whales.

Minke Whales

Impacts from Explosives Under Alternative 1 for Training Activities

Minke whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training activities. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

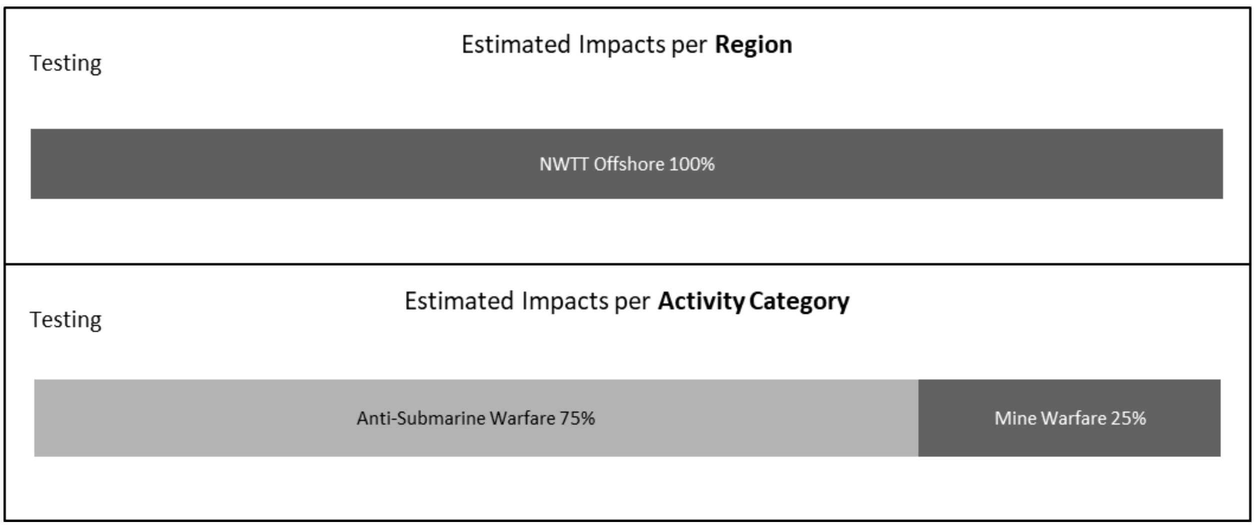
Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of minke whales.

Impacts from Explosives Under Alternative 1 for Testing Activities

Minke whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates behavioral reactions and TTS (Figure 3.4-73 and Table 3.4-86). Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-86).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of minke whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.



Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-73: Minke Whale Impacts Estimated per Year from the Maximum Number of Explosions During Testing Under Alternative 1 and Alternative 2

Table 3.4-86: Estimated Impacts on Individual Minke Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1 and Alternative 2

Estimated Impacts by Effect								
Stock	***Training***				***Testing***			
	Behavioral	***TTS***	***PTS***	***Injury***	***Behavioral***	***TTS***	***PTS***	***Injury***
Alaska	0	0	0	0	0	0	0	0
California, Oregon, & Washington	0	0	0	0	4	2	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1 and Alternative 2.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of minke whales.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities (see Figure 3.4-73 and Table 3.4-86).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of minke whales incidental to those activities.

Humpback Whales (some DPSs are Endangered Species Act-Listed)

Impacts have been modeled for the Hawaii (Central North Pacific stock) population of humpback whales, which are not ESA-Listed, and for the Mexico (California, Oregon, and Washington stock), and Central America (California, Oregon, and Washington stock populations of humpback whales, which are ESA listed. Western North Pacific DPS/stock humpback whales are not likely to be present in the NWTT Study Area during or in proximity to any of the proposed training or testing activities.

Three humpback whale feeding areas have been identified as biologically important areas (Aquatic Mammals, 2015; Calambokidis et al., 2015) in the Offshore Area portion of the Study Area. In addition to procedural mitigation described in Section 5 (Mitigation), the Navy developed the following mitigation areas to avoid or reduce potential impacts from explosives on humpback whales in their important feeding habitats from testing activities, as described in Appendix K (Geographic Mitigation Assessment):

- **Marine Species Coastal Mitigation Area**. The Marine Species Coastal Mitigation Area encompasses the biologically important humpback whale feeding areas. Within 50 NM from shore in the Marine Species Coastal Mitigation Area, the Navy will issue annual seasonal awareness notification messages to alert ships and aircraft to the possible presence of increased seasonal concentrations of humpback whales. To avoid interactions with large whales, the Navy will instruct vessels to remain vigilant to the presence of these species, which may be vulnerable to potential impacts from training and testing activities. Platforms will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation. The Navy will not conduct explosive training activities or explosive testing activities (with the exception of explosive Mine Countermeasure and Neutralization Testing activities) within 50 NM from shore within the Marine Species Coastal Mitigation Area. To the maximum extent practical, the Navy will conduct explosive Mine Countermeasure and Neutralization Testing from July 1 through September 30 when operating within 20 NM from shore in the Marine Species Coastal Mitigation Area. From October 1 through June 30, the Navy will conduct a maximum of one explosive Mine Countermeasure and Neutralization Testing event, not to exceed the use of 20 explosives from bin E4 and 3 explosives from bin E7 annually, and not to exceed the use of 60 explosives from bin E4 and 9 explosives from bin E7 over 7 years. During explosive Mine Countermeasure and Neutralization Testing, the Navy will not use explosives in bin E7 closer than 6 NM from shore in the Quinault Range Site.
- **Olympic Coast National Marine Sanctuary Mitigation Area**. The Olympic Coast National Marine Sanctuary Mitigation Area overlaps a significant portion of the biologically important humpback whale feeding area off northern Washington. Within this mitigation area, the Navy will not conduct explosive Mine Countermeasure and Neutralization Testing activities. This mitigation area is located entirely within 50 NM from shore in the Marine Species Coastal Mitigation Area; therefore, the Navy will not use any explosives for training or testing within the Olympic Coast National Marine Sanctuary Mitigation Area.
- **Juan de Fuca Eddy Marine Species Mitigation Area**. The Juan de Fuca Eddy Marine Species Mitigation Area overlaps important humpback whale feeding habitat off Cape Flattery. Within this mitigation area, the Navy will not conduct explosive Mine Countermeasure and Neutralization Testing activities.
- **Stonewall and Heceta Bank Humpback Whale Mitigation Area**. The portion of the Stonewall and Heceta Bank biologically important feeding area that falls within the Study Area is encompassed by the Stonewall and Heceta Bank Humpback Whale Mitigation Area. In this mitigation area, the Navy will not conduct explosive Mine Countermeasure and Neutralization Testing from May 1 to November 30.
- **Point St. George Humpback Whale Mitigation Area**. The portion of the Point St. George biologically important feeding area that falls within the Study Area is encompassed by the Point St. George Humpback Whale Mitigation Area. In this mitigation area, the Navy will not conduct explosive Mine Countermeasure and Neutralization Testing from July 1 to November 30.

With the exception of a small number of explosive Mine Countermeasure and Neutralization Testing activities, all explosive use in the Offshore portion of the Study Area would occur greater than 50 NM from shore as described above. Explosive use within the Inland Waters portion of the Study Area is also limited. A small number of low net explosive weight charges (2.5 lb. and < 0.1 lb.) would be used during

Mine Neutralization – Explosive Ordnance Disposal training events at Crescent Harbor Explosive Ordnance Disposal (EOD) Training Range and Hood Canal EOD Training Range.

Impacts from Explosives Under Alternative 1 for Training Activities

Humpback whales are present year round in the Offshore Area and seasonally in the Inland Waters portion of the Study Area, where they may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training activities. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

As described in Section 3.4.1.13 (Humpback Whale [*Megaptera novaeangliae*]), proposed critical habitat for the ESA-listed Central America and Mexico DPS of humpback whales overlaps the NWTT Study Area in portions of the Offshore Area, in the Strait of Juan de Fuca, and Western Behm Canal. No explosives would be used during training in Western Behm Canal or the Strait of Juan de Fuca. The majority of the proposed critical habitat in the Offshore Area is within 50 NM from shore with the exception of a small part of Region/Units 14 and 15, which extend westward just beyond this boundary off the coast of Oregon/California. Due to the geographic mitigation areas described above, explosive training activities in the Offshore Area would only occur beyond 50 NM from shore; therefore, explosive use during training would only overlap a portion of Regions/Units 14 and 15 of the proposed critical habitat. All other Regions/Units are within 50 NM from shore and would not be impacted by in-water explosives associated with training activities.

As described in Section 3.4.1.13 (Humpback Whale [*Megaptera novaeangliae*]), one essential feature was identified for humpback whale critical habitat: prey species, primarily euphausiids and small pelagic schooling fishes, of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth. This essential feature has the potential to be affected by explosive use proposed in this action.

The best available science and description of methods used to assess explosive impacts to fishes are provided in Section 3.9.3.2 (Explosive Stressors). As described therein, the thresholds applied to estimate potential mortal impacts are based on a conservative application of available data. Per Table 3.9-8 in Section 3.9.3.2.2.2 (Impact Ranges for Explosives), the average range to fish mortality due to a bin E11 (> 500–650 lb. net explosive weight [NEW]) explosive, the largest explosive proposed in the Offshore Area beyond 50 NM and potentially within Region/Units 14 and 15, is 1,287 m. The ranges for smaller explosive bins that could be used beyond 50 NM from shore are correspondingly shorter. Fish prey items that occur within these portions of designated critical habitat and within the estimated ranges to mortality may be killed. Those that are killed within the proposed critical habitat would no longer be available as prey items. Other potential impacts from exposure to explosions include injury, TTS, physiological stress and behavioral reactions. The ranges to these lower level impacts would be considerably larger than the range to mortality. However, these impacts would not be anticipated to remove individuals (prey) from the population, nor would any non-mortal temporary or isolated impacts to prey items be expected to reduce the quality of prey in terms of nutritional content.

Crustaceans have been shown to be relatively resilient to explosive exposures (see Section 3.8, Marine Invertebrates, in the 2015 NWTT Final EIS/OEIS) and it is anticipated that other invertebrates (including euphausiids) would respond similarly to explosive exposures. Although individuals of widespread marine invertebrate species could be killed during an explosion, the number of such invertebrates affected would be small relative to overall population sizes, and activities would be unlikely to impact survival, growth, recruitment, or reproduction of populations or subpopulations. Impacts of a limited number of explosions on widespread invertebrate populations, and therefore humpback prey items, would likely be undetectable.

If prey items are killed within the critical habitat, it is likely that only a low number of individuals and therefore a small portion of prey species populations may be killed. Although some prey items could be killed within the described mortality ranges during an explosive activity, other prey items would likely be available to humpback whales in the immediate area surrounding the activity or would return to the area after the activity is complete. Exposure to explosions would be highly dependent on the limited number of explosive activities that overlap proposed critical habitat and the actual presence of prey species at the time explosive activities occur. Because the portion of proposed critical habitat beyond 50 NM is limited, only a small portion of Navy activities using explosives in the Offshore Area may occur within the proposed critical habitat. This would result in a minimal change in the overall quantity or availability of prey items within the habitat as a whole. Although some individual prey items may be killed, long-term consequences for fish and invertebrate populations and the effect on overall quantity, quality and availability of prey items would be insignificant. Population-level impacts on fishes and invertebrates in the Study Area from explosive training activities are not anticipated and would not impact humpback whales through a reduction in prey availability.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of humpback whales.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 1 may affect ESA-listed humpback whales and proposed critical habitat for the Central America and Mexico DPSs of humpback whale. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Impacts from Explosives Under Alternative 1 for Testing Activities

Humpback whales present in the Offshore Area portion of the Study Area may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates behavioral reactions and TTS (Figure 3.4-74 and Table 3.4-87). Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (Table 3.4-87).

As described for mysticetes above, even a few minor to moderate behavioral impacts or TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

As described in Section 3.4.1.13 (Humpback Whale [*Megaptera novaeangliae*]), proposed critical habitat for the ESA-listed Central America and Mexico DPS of humpback whales overlaps the NWTT Study Area in portions of the Offshore Area. No explosives would be used during testing in Western Behm Canal or the Strait of Juan de Fuca. The majority of the proposed critical habitat in the Offshore Area is within 50 NM from shore with the exception of a small part of Region/Units 14 and 15, which extend westward just beyond this boundary off the coast of Oregon/California. Due to the geographic mitigation areas described above, most explosive testing activities in the Offshore Area would only occur beyond 50 NM from shore; therefore, explosive use during testing beyond 50 NM from shore may only overlap a portion of Regions/Units 14 and 15 of the proposed critical habitat.

One testing activity using explosives, Mine Countermeasure and Neutralization Testing, would use explosives in bin E4 and bin E7 greater than 3 NM and 6 NM, respectively, from shore in the Quinault Range Site (which is not part of the proposed humpback critical habitat). Outside of the Quinault Range Site, the activity would occur 12 NM or greater from shore off Washington and Oregon. This activity would not be conducted south of the Oregon/California border due to operational requirements; therefore, explosive testing activities will not occur within the nearshore portions of Regions/Units 14 and 15. Mitigation to not conduct detonations in the Olympic Coast National Marine Sanctuary and Juan de Fuca Mitigation Areas will avoid potential effects on humpback whale prey year-round within a portion of Region/Unit 11. Due to the described operational limitations and mitigation measures, the analysis below focuses on prey within a portion of Region/Unit 11 and all of Regions/Units 12 and 13 (i.e., beyond 12 NM south of the Quinault Range) that could be affected by this activity.

As described in Section 3.4.1.13 (Humpback Whale [*Megaptera novaeangliae*]), one essential feature was identified for humpback whale critical habitat: prey species, primarily euphausiids and small pelagic schooling fishes, of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth. This essential feature has the potential to be affected by explosive use proposed in this action.

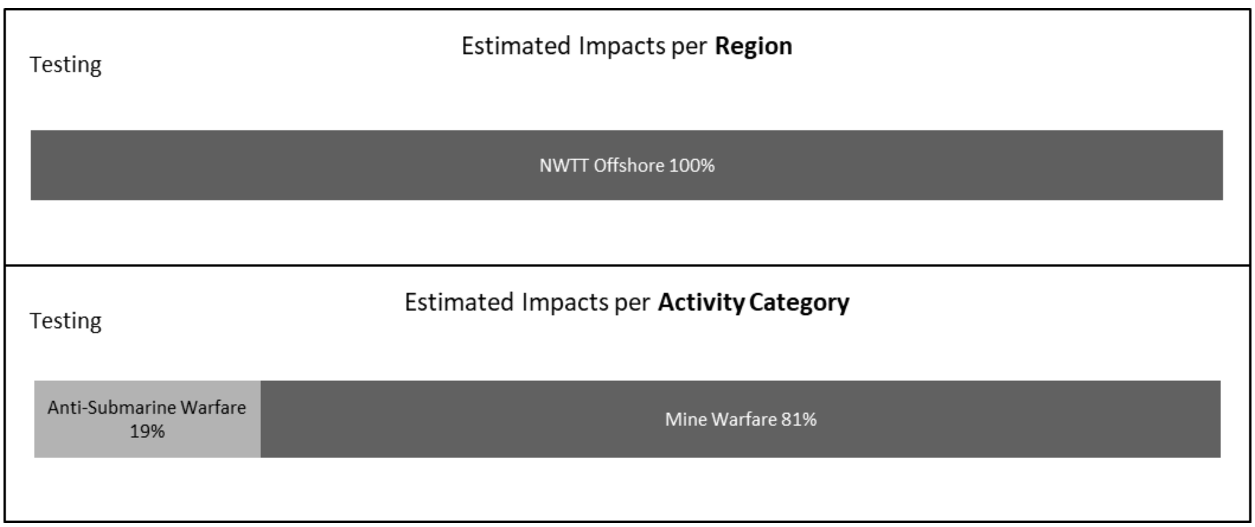
The best available science and description of methods used to assess explosive impacts to fishes are provided in Section 3.9.3.2 (Explosive Stressors). As described therein, the thresholds applied to estimate potential mortal impacts are based on a conservative application of available data. Per Table 3.9-8 in Section 3.9.3.2.2.2 (Impact Ranges for Explosives), the average range to fish mortality due to a bin E7 (> 20–60 lb. NEW) explosive, the largest explosive proposed in the nearshore portion of the Offshore Area and within Region/Units 11, 12 and 13 (due to Mine Countermeasure and Neutralization Testing), is 424 m. The average range to mortality due to a bin E4 (> 2.5–5 lb. NEW) explosive is 150 m. Fish prey items that occur within these portions of designated critical habitat and within the estimated ranges to mortality may be killed. Those that are killed within the proposed critical habitat would no longer be available as prey items. Other potential impacts from exposure to explosions include injury, TTS, physiological stress and behavioral reactions. The ranges to these lower level impacts would be considerably larger than the range to mortality. However, these impacts would not be anticipated to remove individuals (prey) from the population, nor would any non-mortal temporary or isolated impacts to prey items be expected to reduce the quality of prey in terms of nutritional content.

Crustaceans have been shown to be relatively resilient to explosive exposures (see Section 3.8 Marine Invertebrates and Section 3.8 of the 2015 NWTT Final EIS/OEIS) and it is anticipated that other invertebrates (including euphausiids) would respond similarly to explosive exposures. Although individuals of widespread marine invertebrate species could be killed during an explosion, the number of such invertebrates affected would be small relative to overall population sizes, and activities would be unlikely to impact survival, growth, recruitment, or reproduction of populations or subpopulations. Impacts of a limited number of explosions on widespread invertebrate populations, and therefore humpback prey items, would likely be undetectable.

If prey items are killed within the critical habitat, it is likely that only a low number of individuals and therefore a small portion of prey species populations may be killed. Although some prey items could be killed within the described mortality ranges during an explosive activity, other prey items would likely be available to humpback whales in the immediate area surrounding the activity or would return to the area after the activity is complete. Exposure to explosions would be highly dependent on the limited number of explosive activities that overlap proposed critical habitat and the actual presence of prey species at the time explosive activities occur. The portion of Navy activities using explosives within the proposed critical habitat would be small relative to the portion of activities that could occur in the overall Offshore Area, further reducing the potential for effects on prey items. This would result in a minimal change in the overall quantity or availability of prey items within the habitat as a whole. Although some individual prey items may be killed, long-term consequences for fish and invertebrate populations and the effect on overall quantity, quality and availability of prey items would be insignificant. Population-level impacts on fishes and invertebrates in the Study Area from explosive testing activities are not anticipated and would not impact humpback whales through a reduction in prey availability.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of humpback whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 1 may affect ESA-listed humpback whales and proposed critical habitat for the Central America and Mexico DPS of humpback whale. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.



Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-74: Humpback Whale Impacts Estimated per Year from the Maximum Number of Explosions During Testing Under Alternative 1 and Alternative 2

Table 3.4-87: Estimated Impacts on Individual Humpback Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1 and Alternative 2

Estimated Impacts by Effect								
Stock	***Training***				***Testing***			
	Behavioral	***TTS***	***PTS***	***Injury***	***Behavioral***	***TTS***	***PTS***	***Injury***
California, Oregon, & Washington	0	0	0	0	1	1	0	0
Central North Pacific	0	0	0	0	0	1	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1 and Alternative 2.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of humpback whales.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 2 may affect ESA-listed humpback whales.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities (see Figure 3.4-74 and Table 3.4-87).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of humpback whales incidental to those activities.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 2 may affect ESA-listed humpback whales.

Gray Whales (one Population is Endangered Species Act-Listed)

The vast majority of gray whales in the study are from the non-endangered Eastern North Pacific stock, and all of the modeled impacts are attributed to this stock. On rare occasions Western North Pacific gray whales, which are Endangered Species Act-Listed, occur in the Study Area but are not included in this analysis.

Two gray whale feeding areas and one gray whale migration area have been identified as biologically important areas in the Offshore Area portion of the Study Area. In addition to procedural mitigation, the Navy developed the following mitigation areas to avoid or reduce potential impacts from explosives on gray whales in their important feeding and migration habitats, as described in Appendix K (Geographic Mitigation Assessment):

- **Marine Species Coastal Mitigation Area**. The Marine Species Coastal Mitigation Area overlaps a portion of the biologically important gray whale feeding area off northwest Washington and biologically important gray whale migration area in the NWTT Offshore Area. Within 50 NM from shore in the Marine Species Coastal Mitigation Area, the Navy will issue annual seasonal awareness notification messages to alert ships and aircraft to the possible presence of increased seasonal concentrations of gray whales. To avoid interactions with large whales, the Navy will instruct vessels to remain vigilant to the presence of these species, which may be vulnerable to potential impacts from training and testing activities. Platforms will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation. The Navy will not conduct explosive training activities or explosive testing activities (with the exception of explosive Mine Countermeasure and Neutralization Testing activities) within 50 NM from shore within the Marine Species Coastal Mitigation Area. To the maximum extent practical, the Navy will conduct explosive Mine Countermeasure and Neutralization Testing from July 1 through September 30 when operating within 20 NM from shore in the Marine Species Coastal Mitigation Area. From October 1 through June 30, the Navy will conduct a maximum of one explosive Mine Countermeasure and Neutralization Testing event, not to exceed the use of 20 explosives from bin E4 and 3 explosives from bin E7 annually, and not to exceed the use of 60 explosives from bin E4 and 9 explosives from bin E7 over seven years. During explosive Mine Countermeasure and Neutralization Testing, the Navy will not use explosives in bin E7 closer than 6 NM from shore in the Quinault Range Site.
- **Olympic Coast National Marine Sanctuary Mitigation Area**. The Olympic Coast National Marine Sanctuary Mitigation Area overlaps a portion of the biologically important gray whale feeding area off northwest Washington and biologically important gray whale migration area in the NWTT Offshore Area. Within this mitigation area, the Navy will not conduct explosive Mine Countermeasure and Neutralization Testing activities. This mitigation area is located entirely within 50 NM from shore in the Marine Species Coastal Mitigation Area; therefore, the Navy will not use any explosives for training or testing within the Olympic Coast National Marine Sanctuary Mitigation Area.
- **Juan de Fuca Eddy Marine Species Mitigation Area**. The Juan de Fuca Eddy Marine Species Mitigation Area overlaps gray whale migration habitat off Cape Flattery. Within this mitigation area, the Navy will not conduct explosive Mine Countermeasure and Neutralization Testing activities.
- **Puget Sound and Strait of Juan de Fuca Mitigation Area**. The Puget Sound and Strait of Juan de Fuca Mitigation Area encompasses all NWTT Inland Waters and overlaps the biologically important gray whale migration and feeding areas in that portion of the Study Area. Within this mitigation area, the Navy will implement the following mitigation measures for explosives that are likely to avoid or reduce potential impacts on gray whales:
    - The Navy will not use explosives during testing.

- o The Navy will not use explosives during training except at the Hood Canal EOD Range and Crescent Harbor EOD Range during explosive mine neutralization activities involving the use of Navy divers.
- o The Navy will issue annual seasonal awareness notification messages to alert ships and aircraft operating within the Puget Sound and Strait of Juan de Fuca Mitigation Area to the possible presence of seasonal concentrations of gray whales in the Strait of Juan de Fuca and northern Puget Sound. For safe navigation and to avoid interactions with large whales, the Navy will instruct vessels to remain vigilant to the presence of gray whales that may be vulnerable to vessel strikes or potential impacts from training and testing activities. Platforms will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation.

With the exception of a small number of explosive Mine Countermeasure and Neutralization Testing activities, all explosive use in the Offshore portion of the Study Area would occur greater than 50 NM from shore as described above. Explosive use during training activities within the Inland Waters portion of the Study Area is also limited. A small number of low net explosive weight charges (2.5 lb. and 1 oz.) would be used during Mine Neutralization – Explosive Ordnance Disposal training events at Crescent Harbor EOD Training Range and Hood Canal EOD Training Range.

Impacts from Explosives Under Alternative 1 for Training Activities

Gray whales present in the Offshore Area or Inland Waters portions of the Study Area may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training activities. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of gray whales.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 1 may affect ESA-listed gray whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

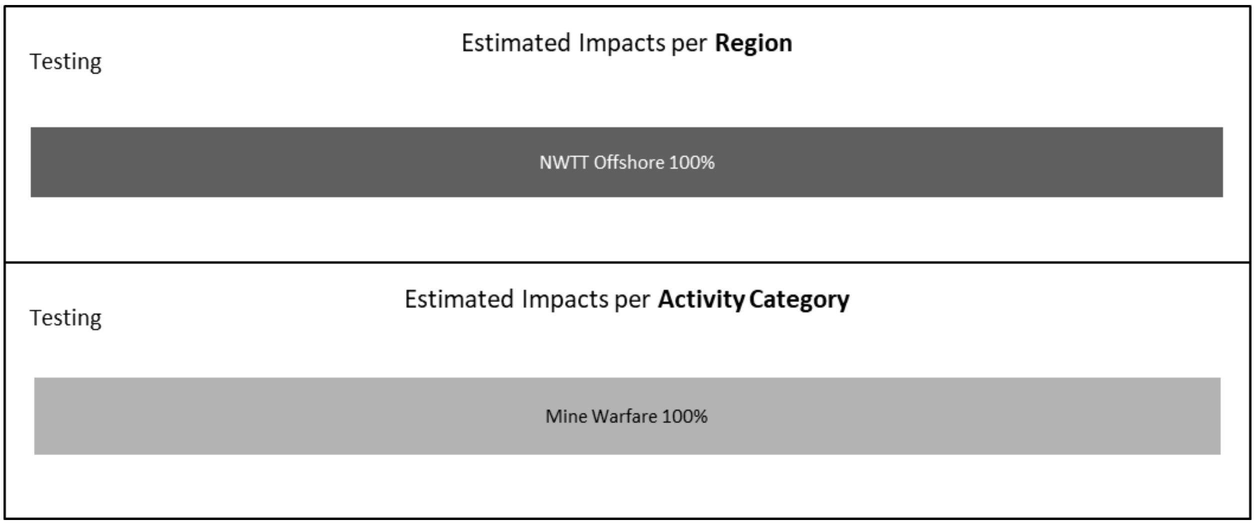
Impacts from Explosives Under Alternative 1 for Testing Activities

Gray whales present in the Offshore Area portion of the Study Area may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates behavioral reactions and TTS (Figure 3.4-75 and Table 3.4-88). Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to the Eastern North Pacific stock (Table 3.4-88).

As described for mysticetes above, even a few minor to moderate behavioral impacts or TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of gray whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 1 may affect ESA-listed gray whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.



Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-75: Gray Whale Impacts Estimated per Year from the Maximum Number of Explosions During Testing Under Alternative 1 and Alternative 2

Table 3.4-88: Estimated Impacts on Individual Gray Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1 and Alternative 2

Estimated Impacts by Effect								
Stock	***Training***				***Testing***			
	Behavioral	***TTS***	***PTS***	***Injury***	***Behavioral***	***TTS***	***PTS***	***Injury***
Eastern North Pacific	0	0	0	0	1	2	0	0
Western North Pacific	0	0	0	0	0	0	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1 and Alternative 2.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of gray whales.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 2 may affect ESA-listed gray whales.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities (see Figure 3.4-75 and Table 3.4-88).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the incidental taking of gray whales.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 2 may affect ESA-listed gray whales.

Odontocetes

Odontocetes may be exposed to sound and energy from explosives associated with training and testing activities throughout the year. Explosions produce sounds that are within the hearing range of odontocetes (see Section 3.4.1.6, Hearing and Vocalization). Potential impacts from explosive energy and sound include non-auditory injury, behavioral reactions, physiological stress, masking and hearing loss. Impact ranges for odontocetes exposed to explosive sound and energy are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives) under mid-frequency cetaceans for most species, and under high-frequency cetaceans for Kogia whales and Dall's porpoises.

Non-auditory injuries to odontocetes, if they did occur, could include anything from mild injuries that are recoverable and are unlikely to have long-term consequences, to more serious injuries, including mortality. It is possible for marine mammals to be injured or killed by an explosion in isolated instances. Animals that did sustain injury could have long-term consequences for that individual. Considering that dolphin species for which these impacts are predicted have populations with tens to hundreds of thousands of animals, removing several animals from the population would be unlikely to have measurable long-term consequences for the species or stocks. As discussed in Section 5.3.3 (Explosive Stressors), the Navy will implement procedural mitigation measures to delay or cease detonations when a marine mammal is sighted in a mitigation zone to avoid or reduce potential explosive impacts.

Odontocetes that do experience a hearing TS from explosive sounds may have reduced ability to detect biologically important sounds (e.g., social vocalizations) until their hearing recovers. Recovery from a hearing TS begins almost immediately after the noise exposure ceases. A TS can take a few minutes to a few days, depending on the severity of the initial shift, to recover. TTS would recover fully and PTS would leave some residual hearing loss. Threshold shifts do not necessarily affect all hearing frequencies equally, and typically manifest themselves at the exposure frequency or within an octave above the exposure frequency. Noise from explosions is broadband with most energy below a few hundred Hertz; therefore, any hearing loss from exposure to explosive sounds is likely to be broadband with effects predominantly at lower frequencies. During the period that an odontocete had hearing loss, social calls from conspecifics and sounds from predators such as killer whale vocalizations could be more difficult to detect or interpret, although many of these sounds may be above the frequencies of the TS. Odontocetes use echolocation clicks to find and capture prey. These echolocation clicks and vocalizations are at frequencies above a few kHz, which are less likely to be affected by TS at lower frequencies, and should not affect odontocete's ability to locate prey or rate of feeding.

Research and observations of masking in marine mammals due to impulsive sounds are discussed in Section 3.4.2.2.1.4 (Masking). Explosions introduce low-frequency, broadband sounds into the environment, which could mask hearing thresholds in odontocetes that are nearby, although sounds from explosions last for only a few seconds at most. Also, odontocetes typically communicate, vocalize, and echolocate at higher frequencies that would be less affected by masking noise at lower frequencies such as those produced by an explosion. Masking due to time-isolated detonations would not be significant. Activities that have multiple detonations such as some naval gunfire exercises could create some masking for odontocetes in the area over the short duration of the event. Potential costs to odontocetes from masking are similar to those discussed above for TTS, with the primary difference being that the effects of masking are only present when the sound from the explosion is present within the water and the effect is over the moment the sound has ceased.

Research and observations (see Section 3.4.2.2.1.5, Behavioral Reactions) show that odontocetes do not typically show strong behavioral reactions to impulsive sounds such as explosions. Reactions, if they did occur, would likely be limited to short ranges, within a few kilometers of multiple explosions. Reactions could include alerting, startling, breaking off feeding dives and surfacing, diving or swimming away, change in vocalization, or showing no response at all. Animals disturbed while engaged in other activities such as feeding or reproductive behaviors may be more likely to ignore or tolerate the disturbance and continue their natural behavior patterns. Because noise from most activities using explosives is short-term and intermittent, and because detonations usually occur within a small area, behavioral reactions from odontocetes are likely to be short-term and low to moderate severity.

Physiological stress could be caused by injury or hearing loss and could accompany any behavioral reaction as well. Research and observations of physiological stress in marine mammals are discussed in Section 3.4.2.2.1.3 (Physiological Stress). Due to the short-term and intermittent use of explosives, physiological stress is also likely to be short-term and intermittent. Long-term consequences from physiological stress due to the sound of explosives would not be expected.

Common Bottlenose Dolphins

Impacts from Explosives Under Alternative 1 for Training Activities

Common bottlenose dolphins may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training activities. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of common bottlenose dolphins.

Impacts from Explosives Under Alternative 1 for Testing Activities

Common bottlenose dolphins may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for testing activities. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 would not result in the incidental taking of common bottlenose dolphins.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of common bottlenose dolphins.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 would not result in the incidental taking of common bottlenose dolphins.

Killer Whales (one DPS is Endangered Species Act-Listed)

For the populations of killer whales present in the Study Area, only the Southern Resident population is listed as endangered under the ESA. Southern Resident killer whales have designated critical habitat in the Inland Waters portion of the Study Area and proposed critical habitat in the NWTT Offshore Area.

In addition to procedural mitigation described in Section 5 (Mitigation), the Navy developed the following mitigation areas to avoid or reduce potential impacts from explosives on killer whales, as described in Appendix K (Geographic Mitigation Assessment):

- **Marine Species Coastal Mitigation Area.** The Marine Species Coastal Mitigation Area overlaps important Southern Resident whale migration and feeding areas, including proposed critical habitat, in the NWTT Offshore Area. Within 50 NM from shore in this mitigation area, the Navy will issue annual seasonal awareness notification messages to alert ships and aircraft to the possible presence of increased concentrations of Southern Resident killer whales. For safe navigation and to avoid interactions with large whales, the Navy will instruct vessels to remain vigilant to the presence of Southern Resident killer whales that may be vulnerable to potential impacts from training and testing activities. Platforms will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation. The Navy will not conduct explosive training activities or explosive testing activities (with the exception of explosive Mine Countermeasure and Neutralization Testing activities) within 50 NM from shore within the Marine Species Coastal Mitigation Area. To the maximum extent practical, the Navy will conduct explosive Mine Countermeasure and Neutralization Testing from July 1 through September 30 when operating within 20 NM from shore in the Marine Species Coastal Mitigation Area. From October 1 through June 30, the Navy will conduct a maximum of one explosive Mine Countermeasure and Neutralization Testing event, not to exceed the use of 20 explosives from bin E4 and 3 explosives from bin E7 annually, and not to exceed the use of 60 explosives from bin E4 and 9 explosives from bin E7 over seven years. During explosive Mine Countermeasure and Neutralization Testing, the Navy will not use explosives in bin E7 closer than 6 NM from shore in the Quinault Range Site.

- **Olympic Coast National Marine Sanctuary Mitigation Area**. The Olympic Coast National Marine Sanctuary Mitigation Area overlaps important Southern Resident killer whale migration and feeding habitats, including proposed critical habitat, in the NWTT Offshore Area. Within this mitigation area, the Navy will not conduct explosive Mine Countermeasure and Neutralization Testing activities. This mitigation area is located entirely within 50 NM from shore in the Marine Species Coastal Mitigation Area; therefore, the Navy will not use any explosives for training or testing within the Olympic Coast National Marine Sanctuary Mitigation Area.
- **Juan de Fuca Eddy Marine Species Mitigation Area**. The Juan de Fuca Eddy Marine Species Mitigation Area overlaps important Southern Resident killer whale migration habitat off Cape Flattery. Within this mitigation area, the Navy will not conduct explosive Mine Countermeasure and Neutralization Testing activities.
- **Puget Sound and Strait of Juan de Fuca Mitigation Area.** The Puget Sound and Strait of Juan de Fuca Mitigation Area encompasses all NWTT Inland Waters and overlaps Southern Resident killer whale critical habitat in that portion of the Study Area. Within this mitigation area, the Navy will implement the following mitigation measures for explosives that are likely to avoid or reduce potential impacts on Southern Resident killer whales:
    - The Navy will not use explosives during testing.
    - The Navy will not use explosives during training except at the Hood Canal EOD Range and Crescent Harbor EOD Range during explosive mine neutralization activities involving the use of Navy divers.
    - Navy event planners will coordinate with Navy biologists during the event planning process prior to explosive mine neutralization activities involving the use of Navy divers. Navy biologists will work with NMFS and will initiate communication with the appropriate marine mammal detection networks to determine the likelihood of Southern Resident killer whale presence in the planned training location. To the maximum extent practicable, Navy planners will use this information when planning specific details of the event (e.g., timing, location, duration) to avoid planning activities in locations or seasons where Southern Resident killer whale presence is expected. The

Navy will ensure environmental awareness of event participants. Environmental awareness will help alert participating crews to the possible presence of applicable species in the training location. Lookouts will use the information to assist visual observation of applicable mitigation zones and to aid in the implementation of procedural mitigation.

- The Navy will issue annual seasonal awareness notification messages to alert ships and aircraft operating within the Puget Sound and Strait of Juan de Fuca Mitigation Area to the possible presence of seasonal concentrations of Southern Resident killer whales. For safe navigation and to avoid interactions with large whales, the Navy will instruct vessels to remain vigilant to the presence of Southern Resident killer whales that may be vulnerable to vessel strikes or potential impacts from training and testing activities. Platforms will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation.

Impacts from Explosives Under Alternative 1 for Training Activities

Killer whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

All explosive use during training in the Offshore portion of the Action Area would occur greater than 50 NM from shore as described above, and the ranges to effect would not extend into the nearshore waters where killer whales in the Southern Resident DPS may be present. In the Offshore Area, killer whales in the Southern Resident DPS may be present throughout the year and tend to stay near the shore, with tag data showing that animals present in the Offshore Area spend 75 percent of their time within 10 NM of the coast (Hanson et al., 2017), with the majority of time (77.7 percent) in waters less than 100 m depth and about half of their time in water depths less than 54 m.

Explosive use within the Inland Waters portion of the Study Area is also limited. A small number of low net explosive weight charges (bin E3 [< 0.5–2.5 lb.] or less) would be used during Mine Neutralization – EOD training events at Crescent Harbor EOD Training Range and Hood Canal EOD Training Range (up to six events in Inland Waters per year). The locations, number of events, and quantities of explosives for this activity are unchanged from the 2015 NWTT Final EIS/OEIS. Killer whales in the Southern Resident DPS are rare in Hood Canal, although they have been sighted in waters near the Crescent Harbor EOD Range. The limited ranges to effect of these small explosives, combined with implementation of procedural mitigation, means the potential for exposure of killer whales in the Southern Resident DPS to explosive sound and energy in Inland Waters is very low. In the unlikely event of Southern Resident DPS presence coincident with one of these events, procedural mitigation has been designed to identify the presence of these easily identified animals prior to commencement of any explosive activities. Consequently, the quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates that the potential for impacts due to training or testing activities is so unlikely as to be discountable. Considering these factors and the mitigation measures that will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or DPS would not be expected.

As described in Section 3.4.1.16, designated critical habitat for the Southern Resident DPS of killer whale occurs in the Inland Waters, and proposed critical habitat occurs in the Offshore Area portion of the Study Area. Essential features for the conservation of the Southern Resident DPS designated and proposed critical habitat include (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging. In the Offshore Area, due to implementation of geographic mitigation, all training involving the use of in-water explosives would occur at distances greater than 50 NM from shore. Therefore, no explosive training activities would occur within the proposed Southern Resident killer whale critical habitat in the Offshore Area.

Explosive stressors during Mine Neutralization – EOD training events at Crescent Harbor EOD Training Range would overlap Southern Resident DPS designated critical habitat in the Inland Waters, as this training range is located outside of but adjacent to the Puget Sound portion of critical habitat. The Crescent Harbor EOD Training Range was excluded from critical habitat designation because the benefits of exclusion for national security were found to outweigh the benefits of inclusion. Of the essential features, only feature (2) may be affected, but is not likely to be adversely affected, by explosive training activities at this site as follows:

- Explosives used during EOD training would not have a plausible route to affect the physical nature of water quality as defined under critical habitat.
- In the Inland Waters portion of the Action Area, the Southern Resident DPS prey primarily on Chinook salmon, in addition to other salmonids and fish species. Use of explosives may kill or injure these prey species if they are present near these small explosives. Per Section 3.9.3.2.2.2 (Impact Ranges for Explosives) in the Fishes section, the average range to fish mortality due to a bin E3 (> 0.5–2.5 lb. NEW) explosive, the largest explosive proposed in the Inland Waters portion of the Action Area, is 140 m. Over multiple years (2002–2018) of monitoring EOD underwater detonations, most observed mortalities were Pacific herring, which comprise only 0.75 percent of the Southern resident killer whale diet. There have been no observed mortalities of Pacific salmonids. The Navy would minimize the potential for injurious exposures to prey species under the following requirements outlined in Section 5.3.3.7 (Explosive Mine Neutralization Activities Involving Navy Divers). At the Crescent Harbor EOD Range, the Navy will conduct explosive activities at least 1,000 m from the closest point of land to avoid or reduce impacts on fish (e.g., juvenile Chinook salmon) in nearshore habitat areas.

  The range to fish mortality would not extend into the designated critical habitat next to the Crescent Harbor EOD range site (note that the other EOD range site in Inland Waters is in Hood Canal and is not proximate to designated critical habitat). The results of hydroacoustic monitoring at the Crescent Harbor EOD range site suggest that pressure levels would not typically be exceed fish injury thresholds in adjacent critical habitat.

  Although any impacts on prey fishes would be limited due to implementation of the above mitigation and the small number and size of explosives proposed for use in the Inland Waters portion of the Action Area, a small number of prey items that could have been present in the nearby critical habitat could no longer be available; however, injuries would not be anticipated to remove prey items from the population. The number of fish that could be potentially killed in the small area of effect relative to fish presence in or near critical habitat would be insignificant relative to the 2019 pre-season forecast for the Puget Sound summer/fall Chinook run of approximately a quarter of a million adult fish (Pacific Fishery Management Council, 2019). Thus a small number of mortalities would not appreciably diminish the conservation value of the habitat as a whole.

- Since sound and energy from these small explosions would be short in duration and would occur a very limited number of times within any year, there would be no plausible route to obstruct waterways or impact the conservation function of passage conditions to allow for migration, resting, and foraging in designated critical habitat.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of killer whales.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 1 may affect ESA-listed killer whales and designated critical habitat for Southern Resident killer whales in the Inland Waters. The Navy has consulted with NMFS as required by section 7(a)(2). The use of explosives during training activities would have no effect on proposed critical habitat for Southern Resident killer whales in the Offshore Area.

Impacts from Explosives Under Alternative 1 for Testing Activities

Killer whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for testing activities. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Explosives would not be used during testing in the Inland Waters portion of the Study Area. With the exception of a small number of explosive mine countermeasure and neutralization testing activities, all explosive use during testing in the Offshore portion of the Study Area would occur greater than 50 NM from shore as described above, and the ranges to effect would not extend into the nearshore waters where killer whales in the Southern Resident DPS may be present. In the Offshore Area, killer whales in the Southern Resident DPS may be present throughout the year and tend to stay near the shore, with tag data showing that animals present in the Offshore Area spend 75 percent of their time within 10 NM of the coast (Hanson et al., 2017), with the majority of time (77.7 percent) in waters less than 100 m depth and about half of their time in water depths less than 54 m.

Mine Countermeasure and Neutralization Testing is a new testing activity that would occur closer to shore than other in-water explosive activities analyzed in the 2015 NWTT Final EIS/OEIS for the Offshore Area. During this activity, explosives in bin E4 and bin E7 would be used greater than 3 NM and 6 NM, respectively, from shore in the Quinault Range Site, and greater than 12 NM from shore off Washington and Oregon in the Offshore Area. Explosive mine countermeasure and neutralization testing activities, therefore, could occur in waters potentially inhabited by the Southern Resident DPS, but would occur in waters deeper than those typically preferred by the Southern Resident DPS. Observation of the mitigation zones both before and during testing events (Section 5.3.3.6, Explosive Mine Countermeasure and Neutralization Testing Activities) would significantly reduce any potential for injurious exposures in the Offshore Area.

The potential for overlap of explosive energy with presence of the Southern Resident DPS is very low due to the limited number of these events (up to two explosive Mine Countermeasure and Neutralization Testing activities in the Offshore Area per year) and low likelihood of animal presence. In the unlikely event of Southern Resident DPS presence coincident with one of these events, procedural mitigation has been designed to identify the presence of these easily identified animals prior to commencement of any explosive activities. Consequently, the quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates that the potential for impacts due to training or testing activities is so unlikely as to be discountable. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

As described in Section 3.4.1.16, designated critical habitat for the Southern Resident DPS of killer whale occurs in the Inland Waters, and proposed critical habitat occurs in the Offshore Area portion of the Study Area. Essential features for the conservation of the Southern Resident DPS designated and proposed critical habitat include (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging. All testing involving explosives would occur greater than 50 NM from shore in the Offshore Area, with the exception of explosive Mine Countermeasure and Neutralization Testing activities described above. Therefore, no explosive testing activities would overlap designated critical habitat in the Inland Waters, and no explosive testing activities in the Offshore Area would overlap proposed critical habitat, with the exception of Mine Countermeasure and Neutralization Testing conducted greater than 12 NM from shore off Oregon and Washington outside of the Quinault Range Site. NMFS has proposed to exclude the Quinault Range with a 10-km buffer from critical habitat designation for national security purposes. This activity is not conducted south of the Oregon/California border due to operational requirements; therefore, explosive testing activities will not occur within proposed critical habitat Coastal Area 4. Under the above described geographic mitigation, detonations would not be conducted in the Olympic Coast National Marine Sanctuary and Juan de Fuca Mitigation Areas, so explosive stressors would not overlap all of proposed critical habitat Coastal Area 1 and a portion of proposed critical habitat Coastal Area 2. Due to the described operational limitations and geographic mitigation measures, the analysis below focuses on explosive stressor overlap with proposed critical habitat Coastal Areas 2 and 3 (i.e., beyond 12 NM south of the Quinault Range).

Of the essential features, only feature (2) may be affected, but is not likely to be adversely affected, by explosive Mine Countermeasure and Neutralization Testing activities in the Offshore Area as follows:

1. Explosives used during Mine Countermeasure and Neutralization testing would not have a plausible route to affect the physical nature of water quality as defined under critical habitat.

   Sound and energy from explosive testing activities proposed in this action has the potential to affect prey species within the proposed critical habitat. Specifically, prey species, including Chinook and other salmonids, that are present near an explosion during Mine Countermeasure and Neutralization Testing activities, may be killed. Fish that are killed within the proposed critical habitat would no longer be available as prey items. Other potential impacts from exposure to explosions include injury, potential behavioral effects associated with exposures resulting in TTS, physiological stress, and other behavioral reactions. Although the ranges to these effects would be considerably larger than the range to mortality, these impacts would not be anticipated to remove individuals from the population. Nor would any non-mortal temporary or isolated impacts to prey items be expected to reduce the quality of prey in terms of nutritional content.

The best available science and description of methods used to assess explosive impacts to fishes are provided in Section 3.9.3.2 (Explosive Stressors). As described therein, the thresholds applied to estimate potential mortal impacts are based on a conservative application of available data. The explosive testing activity that could occur within the proposed Southern Resident killer whale critical habitat includes explosive bins E4 and E7. Per Table 3.9-8 in Section 3.9.3.2.2.2 (Impact Ranges for Explosives), the average range to mortality due to a bin E4 (> 2.5–5 lb. Net Explosive Weight [NEW]) explosive is 150 m. The average range to fish mortality due to a bin E7 (> 20–60 lb. NEW) explosive, the largest explosive proposed in the nearshore portion of the Study Area, is 424 m.

If prey items are killed within the critical habitat, it is likely that other prey items would be available to killer whales in the immediate area surrounding the activity, or would return to the area after the activity is complete. Exposure to explosions would be highly dependent on the actual presence of prey species in the proposed critical habitat at the time this activity takes place. Overall, the overlap of explosive energy with presence of Southern Resident prey species would be very low due to the limited number of these activities. This would result in a minimal change in the overall quantity and availability of prey items within the habitat as a whole. Although some individual prey items may be killed, long-term consequences for fish populations and the effect on overall quantity, quality, and availability of prey items would be insignificant. Millions of salmon are harvested each year in commercial and recreational fisheries. In addition, contemporary abundances of Chinook salmon in the Pacific Northwest and California have been greatly reduced from historic abundances (Fisheries and Oceans Canada, 2018; Murray et al., 2019; Ward et al., 2013). Taking into consideration this information, scientific panels reviewed the potential for reductions in Chinook salmon harvest to increase prey availability for Southern Resident killer whales and determined that the long-term benefits to Southern Resident killer whales from such reductions would to be minimal, small, or "overwhelmingly low" (Hilborn et al., 2012; Trites & Rosen, 2018). In addition, NMFS estimated that fishery research activities in 2019 would remove in excess of 116,000 salmon from the NWTT Action Area. NMFS concluded that the removal of approximately 100,000 salmon in one year would not have a meaningful or measurable effect on prey availability, that the potential adverse effects of the salmon removals on Southern Resident killer whales would be insignificant, and that the Proposed Action may affect, but is not likely to adversely affect, Southern Resident killer whales or their critical habitat (National Marine Fisheries Service, 2019d). In comparison and even considering a worst-case analysis, potential impacts to salmon availability from Navy's proposed activities would be magnitudes less than the minimal or small effect fishery harvests have on salmon abundance in the area. Because the overlapping Navy explosive stressors have a very small zone of impact in relation to the area of the critical habitat, the explosive stressors have a relatively short duration, and a limited number of explosive activities would occur in proposed critical habitat in any year, the potential magnitude of mortality of prey items would be insignificant in relationship to the quantity, quality, or overall prey availability to support individual growth, reproduction, and development, as well as overall population growth within the critical habitat.

2. Since sound and energy from these small explosions would be short in duration and would occur a very limited number of times within any year, there would be no plausible route to obstruct waterways or impact the conservation function of passage conditions to allow for migration, resting, and foraging in designated critical habitat.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 would not result in the incidental taking of killer whales.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 1 may affect ESA-listed killer whales and proposed critical habitat for Southern Resident killer whales in the Offshore Area. The Navy has consulted with NMFS as required by Section 7(a)(2). The use of explosives during testing activities would have no effect on designated critical habitat for Southern Resident killer whales in the Inland Waters.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of killer whales.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 2 may affect ESA-listed killer whales and designated critical habitat for Southern Resident killer whales in the Inland Waters. The use of explosives during training activities would have no effect on proposed critical habitat for Southern Resident killer whales in the Offshore Area.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 would not result in the incidental taking of killer whales.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 2 may affect ESA-listed killer whales and proposed critical habitat for Southern Resident killer whales in the Offshore Area. The use of explosives during testing activities would have no effect on designated critical habitat for Southern Resident killer whales in the Inland Waters.

Northern Right Whale Dolphins

Impacts from Explosives Under Alternative 1 for Training Activities

Northern right whale dolphins may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

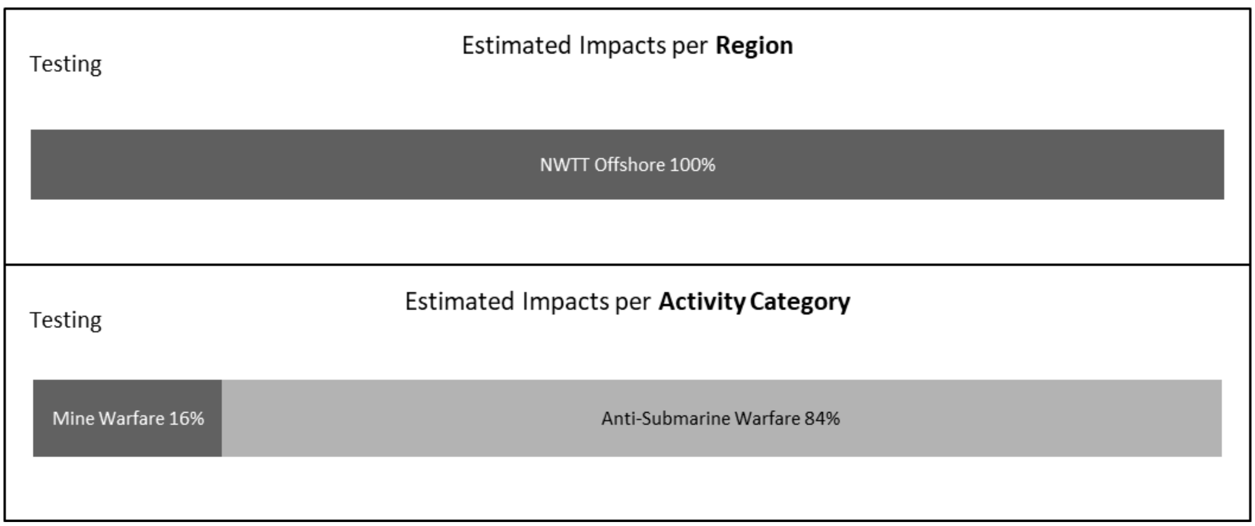
Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of Northern right whale dolphins.

Impacts from Explosives Under Alternative 1 for Testing Activities

Northern right whale dolphins may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates behavioral reactions and TTS (Figure 3.4-76 and Table 3.4-89). Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-89).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of Northern right whale dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.



Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-76: Northern Right Whale Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Testing Under Alternative 1

Table 3.4-89: Estimated Impacts on Individual Northern Right Whale Dolphin Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1

Estimated Impacts by Effect								
Stock	***Training***				***Testing***			
	Behavioral	***TTS***	***PTS***	***Injury***	***Behavioral***	***TTS***	***PTS***	***Injury***
California, Oregon, & Washington	0	0	0	0	1	1	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Explosives Under Alternative 2 for Training Activities

The quantitative analysis, using the maximum number of explosions per year under Alternative 2, estimates TTS (Figure 3.4-77 and Table 3.4-90). Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-90). The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

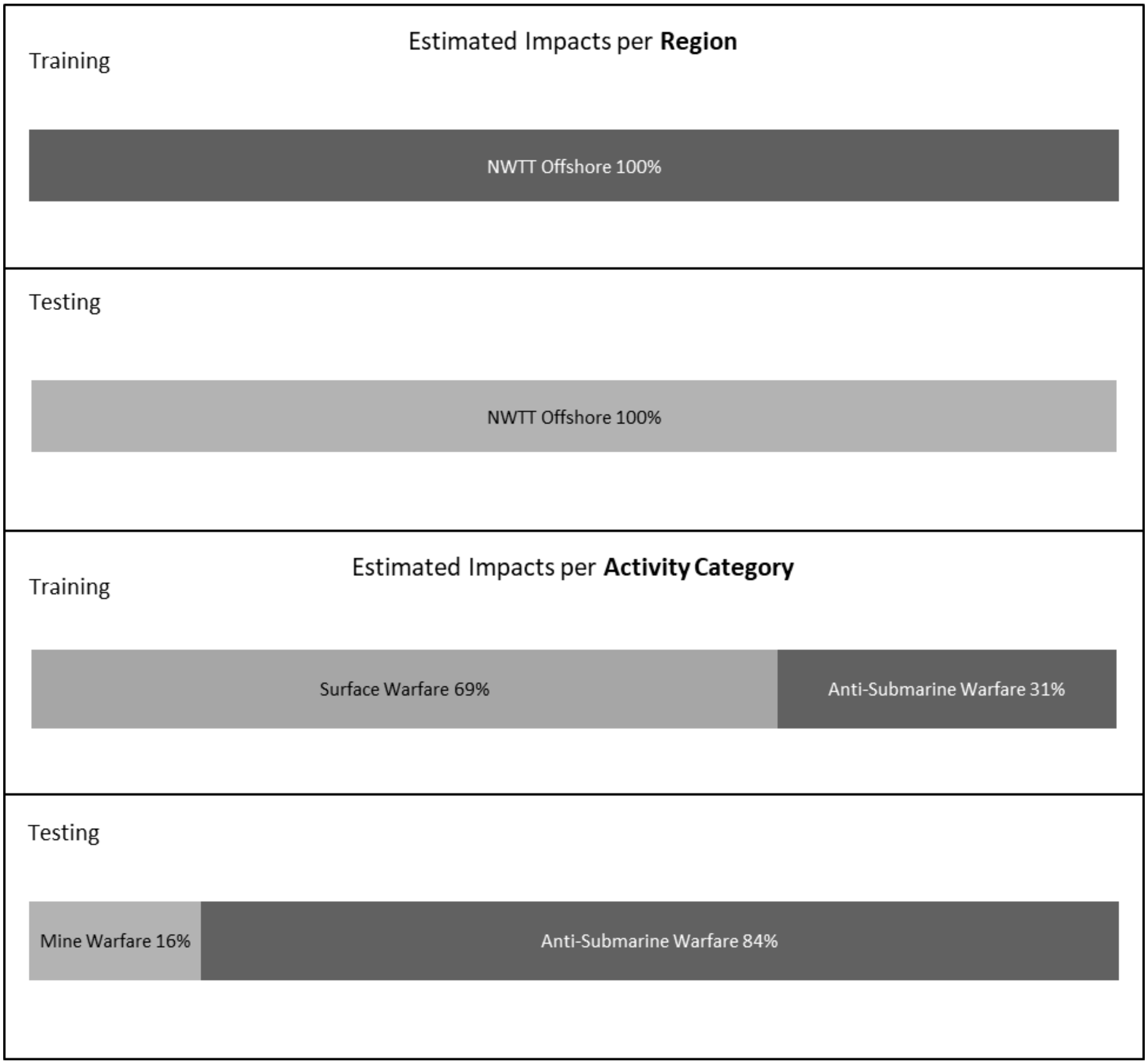
As described for odontocetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of Northern right whale dolphins incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

Potential annual impacts on this species under Alternative 2 from testing with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities (see Figure 3.4-76 and Table 3.4-90). Therefore, over a multi-year period, the number of impacts for this species from testing under Alternative 2 would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of northern right whale dolphins incidental to those activities.



Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-77: Northern Right Whale Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 2

Table 3.4-90: Estimated Impacts on Individual Northern Right Whale Dolphin Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 2

Estimated Impacts by Effect								
Stock	*Training*				*Testing*			
	Behavioral	*TTS*	*PTS*	*Injury*	*Behavioral*	*TTS*	*PTS*	*Injury*
California, Oregon, & Washington	0	1	0	0	1	1	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Pacific White-Sided Dolphins

Impacts from Explosives Under Alternative 1 for Training Activities

Pacific white-sided dolphins may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts from training. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

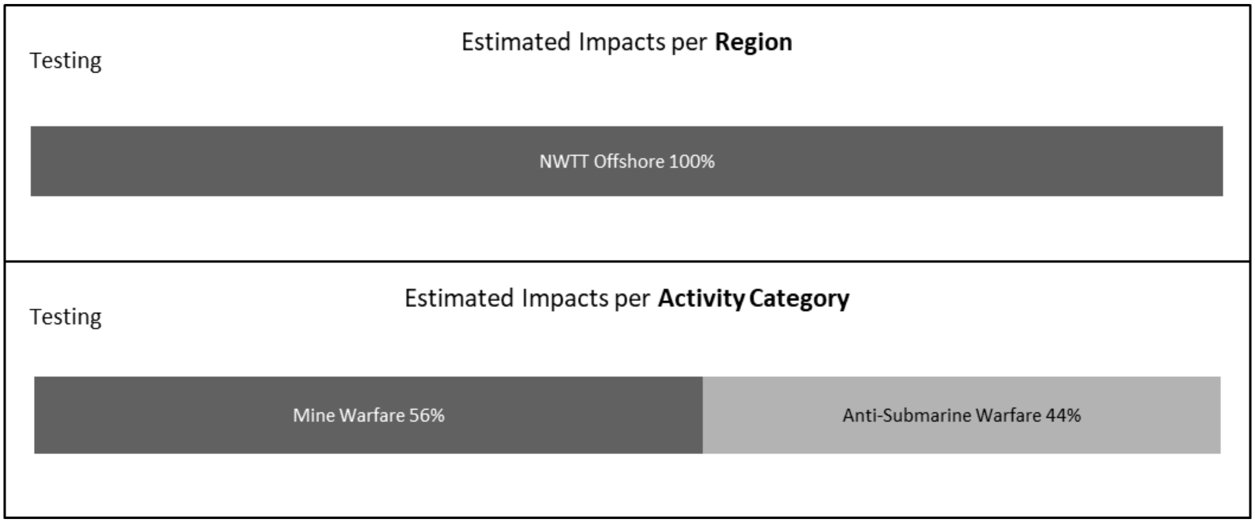
Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of Pacific white-sided dolphins.

Impacts from Explosives Under Alternative 1 for Testing Activities

Pacific white-sided dolphins may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates behavioral reactions and TTS (Figure 3.4-78 and Table 3.4-91). Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-91).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of Pacific white-sided dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.



Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-78: Pacific White-Sided Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Testing Under Alternative 1

Table 3.4-91: Estimated Impacts to Individual Pacific White-Sided Dolphin Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1

Estimated Impacts by Effect								
Stock	***Training***				***Testing***			
	Behavioral	***TTS***	***PTS***	***Injury***	***Behavioral***	***TTS***	***PTS***	***Injury***
California, Oregon, & Washington	0	0	0	0	1	1	0	0
North Pacific	0	0	0	0	0	0	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Explosives Under Alternative 2 for Training Activities

The quantitative analysis, using the maximum number of explosions per year under Alternative 2, estimates TTS (Figure 3.4-79 and Table 3.4-92). Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-92). The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

As described for odontocetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of Pacific white-sided dolphins incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities (see Figure 3.4-78 and Table 3.4-92).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of Pacific white-sided dolphins incidental to those activities.

Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-79: Pacific White-Sided Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 2

Table 3.4-92: Estimated Impacts to Individual Pacific White-Sided Dolphin Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 2

Estimated Impacts by Effect								
Stock	***Training***				***Testing***			
	Behavioral	***TTS***	***PTS***	***Injury***	***Behavioral***	***TTS***	***PTS***	***Injury***
California, Oregon, & Washington	0	1	0	0	1	1	0	0
North Pacific	0	0	0	0	0	0	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Risso's Dolphins

Impacts from Explosives Under Alternative 1 for Training Activities

Risso's dolphins may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training activities. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

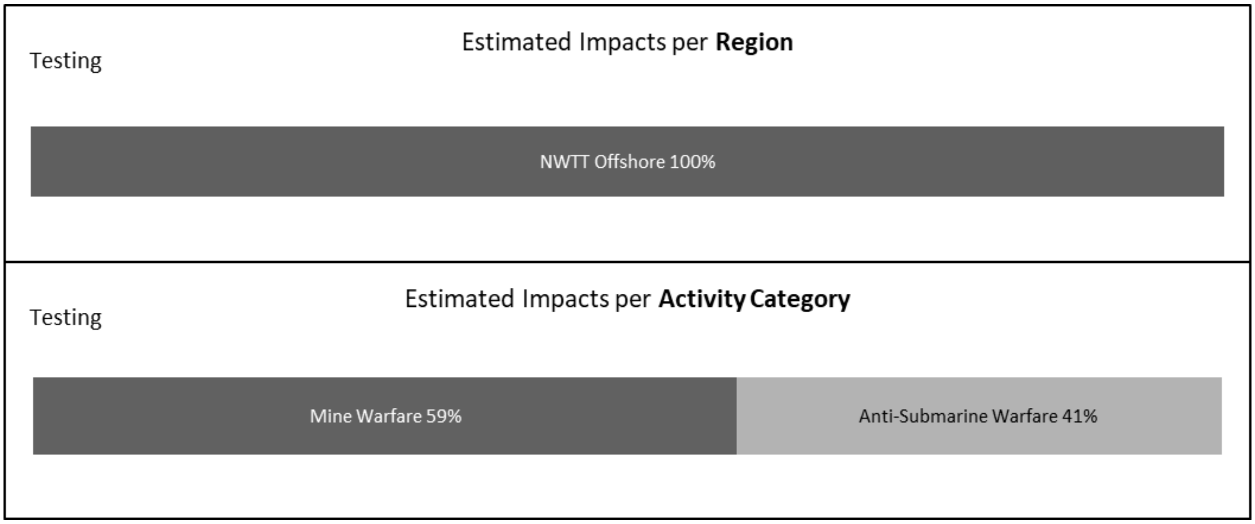
Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of Risso's dolphins.

Impacts from Explosives Under Alternative 1 for Testing Activities

Risso's dolphins may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates TTS (Figure 3.4-80 and Table 3.4-93) for testing activities. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-93).

As described for odontocetes above, even a few minor to moderate TTS reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of Risso's dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.



Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 99–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-80: Risso's Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1 and Alternative 2

Table 3.4-93: Estimated Impacts on Individual Risso Dolphins Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1 and Alternative 2

Estimated Impacts by Effect								
Stock	Training				Testing			
	Behavioral	TTS	PTS	Injury	Behavioral	TTS	PTS	Injury
California, Oregon, & Washington	0	0	0	0	0	1	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of Risso's dolphins.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities (see Figure 3.4-80 and Table 3.4-93).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the incidental taking of Risso's dolphins incidental to those activities.

Short-Beaked Common Dolphin

Impacts from Explosives Under Alternative 1 for Training Activities

Short-beaked common dolphins may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training activities. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of short-beaked common dolphins.

Impacts from Explosives Under Alternative 1 for Testing Activities

Short-beaked common dolphins may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for testing. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 would not result in the incidental taking of short-beaked common dolphins.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of short-beaked common.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 would not result in the incidental taking of short-beaked common dolphins.

Short-Finned Pilot Whales

Impacts from Explosives Under Alternative 1 for Training Activities

Short-finned pilot whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training activities. Impact ranges for these species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of short-finned pilot whales.

Impacts from Explosives Under Alternative 1 for Testing Activities

Short-finned pilot whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for testing. Impact ranges for these species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 would not result in the incidental taking of short-finned pilot whales.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of short-finned pilot whales.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 would not result in the incidental taking of short-finned pilot whales.

Striped Dolphins

Impacts from Explosives Under Alternative 1 for Training Activities

Striped dolphins may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training activities. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of striped dolphins.

Impacts from Explosives Under Alternative 1 for Testing Activities

Striped dolphins may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for testing activities. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 would not result in the incidental taking of striped dolphins.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of striped dolphins.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 would not result in the incidental taking of striped dolphins.

Kogia Whales

Kogia whales include two species that are often difficult to distinguish from one another: dwarf sperm whales and pygmy sperm whales.

TTS and PTS thresholds for high-frequency cetaceans, such as Kogia whales are lower than for all other marine mammals, which leads to a higher number of estimated hearing loss impacts relative to the number of animals exposed to the sound as compared to other hearing groups (e.g., mid-frequency cetaceans).

Impacts from Explosives Under Alternative 1 for Training Activities

Kogia whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training activities. Impact ranges for these species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

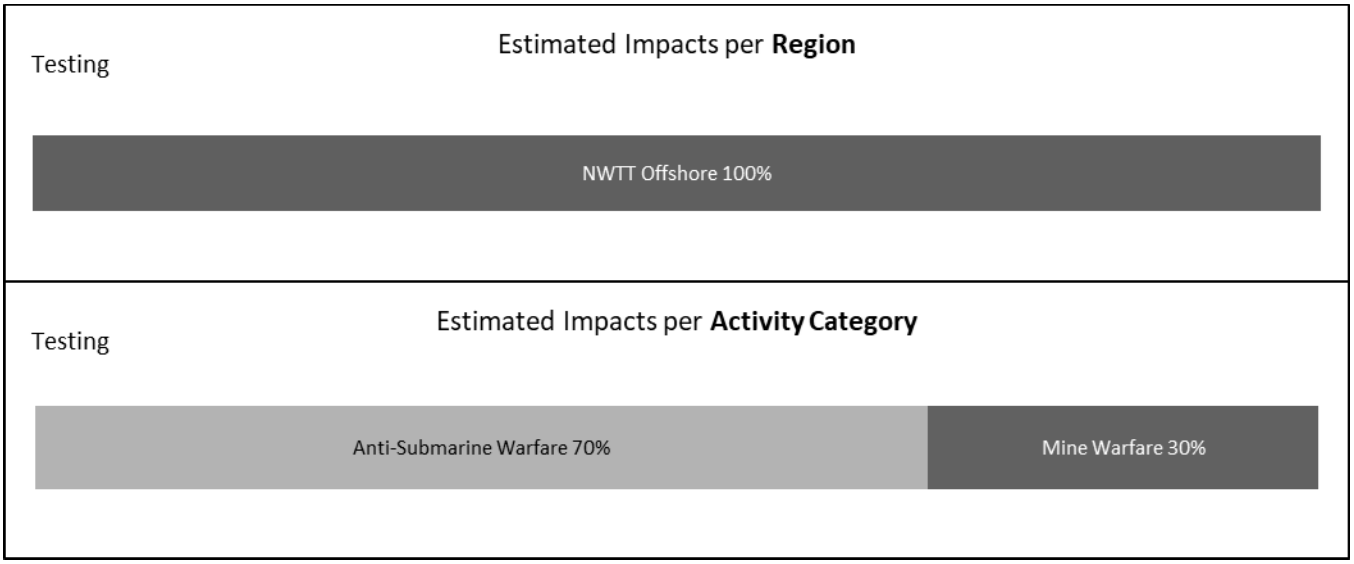
Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of Kogia whales (dwarf and pygmy sperm whales).

Impacts from Explosives Under Alternative 1 for Testing Activities

Kogia whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts on dwarf sperm whales for testing activities. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates behavioral reactions, TTS, and PTS for pygmy sperm whales (Figure 3.4-81, Table 3.4-94, and tabular results in Appendix E, Estimated Marine Mammal and Sea Turtle Impacts from Exposure to Acoustic and Explosive Stressors under Navy Training and Testing Activities). Impact ranges for these species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts to Kogia whales apply to the California, Oregon, and Washington stocks.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 would result in the unintentional taking of Kogia whales (dwarf and pygmy sperm whales) incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.



Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-81: Kogia Whales Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Table 3.4-94: Estimated Impacts on Individual Kogia Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1

Estimated Impacts by Effect								
Stock	Training				Testing			
	Behavioral	TTS	PTS	Injury	Behavioral	TTS	PTS	Injury
California, Oregon, & Washington	0	0	0	0	1	3	2	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Explosives Under Alternative 2 for Training Activities

The quantitative analysis, using the maximum number of explosions per year under Alternative 2 for training activities, estimates no impacts on dwarf sperm whales and TTS for pygmy sperm whales (Figure 3.4-82, Table 3.4-95, and tabular results in Appendix E, Estimated Marine Mammal and Sea Turtle Impacts from Exposure to Acoustic and Explosive Stressors under Navy Training and Testing Activities). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts to Kogia whales apply only to the California, Oregon, and Washington stocks. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

As described for odontocetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of Kogia whales (dwarf and pygmy sperm whales) incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of Kogia whales (dwarf and pygmy sperm whales) incidental to those activities.

Note: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-82: Kogia Whales Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 2

Table 3.4-95: Estimated Impacts on Individual Kogia Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 2

Stock	Training				Testing			
	Behavioral	TTS	PTS	Injury	Behavioral	TTS	PTS	Injury
California, Oregon, & Washington	0	1	1	0	1	3	2	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Dall's Porpoises

TTS and PTS thresholds for high-frequency cetaceans, such as Dall's porpoises, are lower than for all other marine mammals, which leads to a higher number of estimated hearing loss impacts relative to the number of animals exposed to the sound as compared to other hearing groups (e.g., mid-frequency cetaceans).

Impacts from Explosives Under Alternative 1 for Training Activities

Dall's porpoises may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates behavioral reactions, TTS, and PTS (Figure 3.4-83 and Table 3.4-96). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-96).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 will result in the unintentional taking of Dall's porpoises incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Impacts from Explosives Under Alternative 1 for Testing Activities

Dall's porpoises may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates behavioral reactions, TTS, and PTS (Figure 3.4-83 and Table 3.4-96). Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to the California, Oregon, and Washington stock (Table 3.4-96).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences

for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of Dall's porpoises incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-83: Dall's Porpoise Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Table 3.4-96: Estimated Impacts on Individual Dall's Porpoise Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1

Estimated Impacts by Effect								
Stock	***Training***				***Testing***			
	Behavioral	***TTS***	***PTS***	***Injury***	***Behavioral***	***TTS***	***PTS***	***Injury***
Alaska	0	0	0	0	0	0	0	0
California, Oregon, & Washington	4	16	2	0	52	177	66	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Explosives Under Alternative 2 for Training Activities

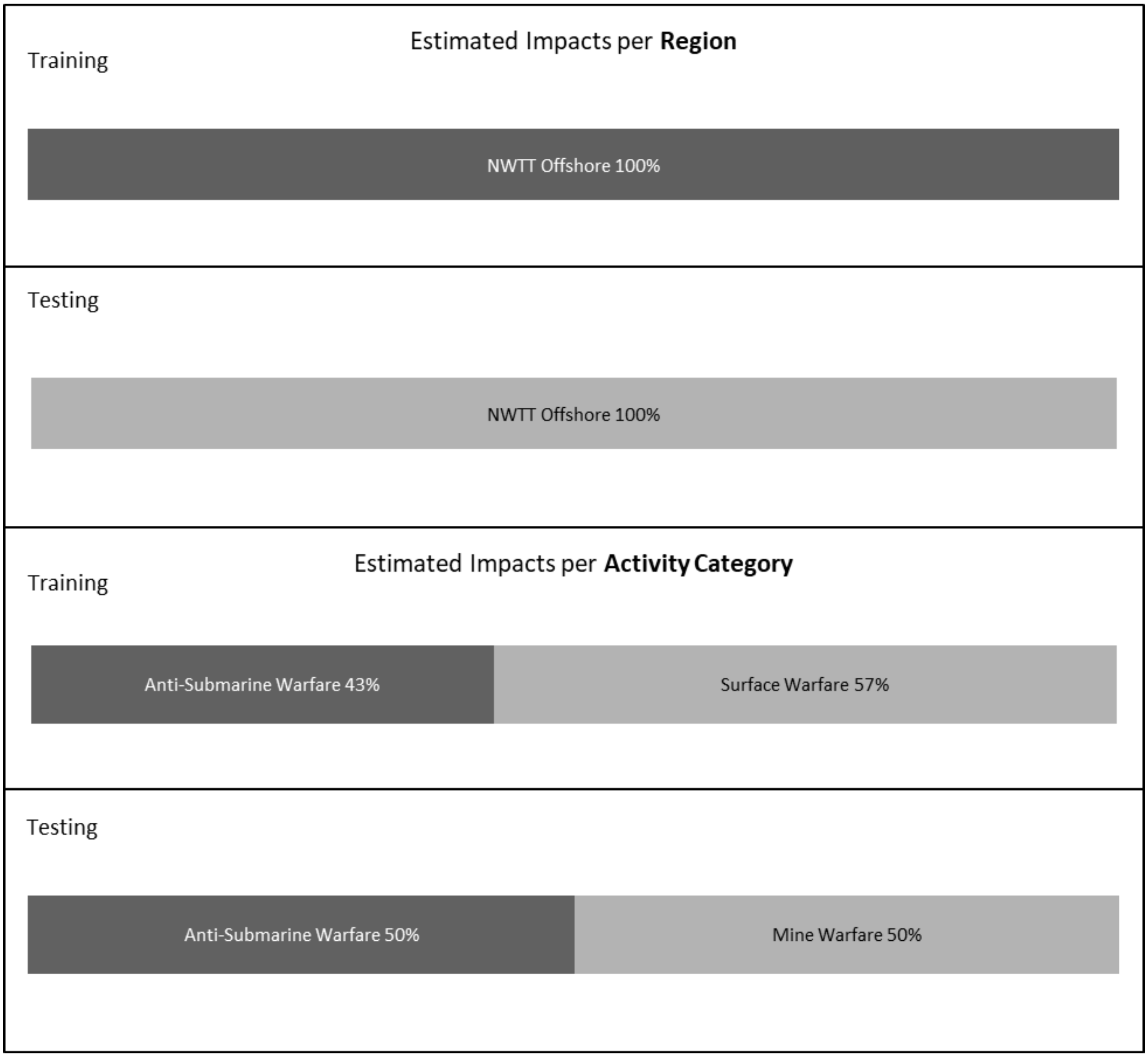
Potential annual impacts under Alternative 2 from training with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities (Figure 3.4-84 and Table 3.4-97). The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of Dall's porpoises incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities (Figure 3.4-84 and Table 3.4-97).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of Dall's porpoises incidental to those activities.



Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-84: Dall's Porpoise Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 2

Table 3.4-97: Estimated Impacts on Individual Dall's Porpoise Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 2

Estimated Impacts by Effect								
Stock	***Training***				***Testing***			
	Behavioral	***TTS***	***PTS***	***Injury***	***Behavioral***	***TTS***	***PTS***	***Injury***
Alaska	0	0	0	0	0	0	0	0
California, Oregon, & Washington	4	39	6	0	52	177	66	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Harbor Porpoises

TTS and PTS thresholds for high-frequency cetaceans, such as harbor porpoises, are lower than for all other marine mammals, which leads to a higher number of estimated hearing loss impacts relative to the number of animals exposed to the sound as compared to other hearing groups (e.g., mid-frequency cetaceans).

In addition to procedural mitigation, mitigation within the Stonewall and Heceta Bank Humpback Whale Mitigation Area will also help avoid or reduce potential impacts on harbor porpoises. Harbor porpoises are known to congregate for feeding at Heceta Bank. In this mitigation area, the Navy will not conduct explosive Mine Countermeasure and Neutralization Testing from May 1 to November 30.

Impacts from Explosives Under Alternative 1 for Training Activities

Harbor porpoises may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates TTS and PTS (Figure 3.4-85and Table 3.4-98). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to the Washington Inland Waters stock (Table 3.4-98).

As described for odontocetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 will result in the unintentional taking of harbor porpoises incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Impacts from Explosives Under Alternative 1 for Testing Activities

Harbor porpoises may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates behavioral reactions, TTS, and PTS (Figure 3.4-85 and Table 3.4-98). Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (Table 3.4-98).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of harbor porpoises incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-85: Harbor Porpoise Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1 and Alternative 2

Table 3.4-98: Estimated Impacts on Individual Harbor Porpoise Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1

Estimated Impacts by Effect								
Stock	Training				Testing			
	Behavioral	TTS	PTS	Injury	Behavioral	TTS	PTS	Injury
Southeast Alaska	0	0	0	0	0	0	0	0
Northern Oregon/ Washington Coast	0	0	0	0	55	194	84	0
Northern California/ Southern Oregon	0	0	0	0	91	214	86	0
Washington Inland Waters	0	61	27	0	0	0	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities (see Table 3.4-99). The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of harbor porpoises incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities (see Table 3.4-99).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of harbor porpoises incidental to those activities.

Table 3.4-99: Estimated Impacts on Individual Harbor Porpoise Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 2

Estimated Impacts by Effect								
Stock	***Training***				***Testing***			
	Behavioral	***TTS***	***PTS***	***Injury***	***Behavioral***	***TTS***	***PTS***	***Injury***
Southeast Alaska	0	0	0	0	0	0	0	0
Northern Oregon/ Washington Coast	0	0	0	0	55	194	84	0
Northern California/ Southern Oregon	0	0	0	0	91	214	86	0
Washington Inland Waters	0	102	45	0	0	0	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Sperm Whales (Endangered Species Act-Listed)

Impacts from Explosives Under Alternative 1 for Training Activities

Sperm whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training activities (see Table E-5 and tabular results in Appendix E, Estimated Marine Mammal and Sea Turtle Impacts from Exposure to Acoustic and Explosive Stressors under Navy Training and Testing Activities). Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of sperm whales.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 1 may affect ESA-listed sperm whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Impacts from Explosives Under Alternative 1 for Testing Activities

Sperm whales present in the Offshore Area portion of the Study Area may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for testing activities. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 would not result in the incidental taking of sperm whales.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 1 may affect ESA-listed sperm whales. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of sperm whales.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 2 may affect ESA-listed sperm whales.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 would not result in the incidental taking of sperm whales.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 2 may affect ESA-listed sperm whales.

Beaked Whales

Beaked whales within the NWTT study area include Baird's beaked whale, Blainville's beaked whale, Cuvier's beaked whale, Hubb's beaked whale, ginkgo-toothed beaked whale, Perrin's beaked whale, Stejneger's beaked whale, and the pygmy beaked whale. Impacts to Blainville's beaked whale, Hubb's beaked whale, ginkgo-toothed beaked whale, Perrin's beaked whale, Stejneger's beaked whale and the pygmy beaked whale are combined and represented in the beaked whale guild (*Mesoplodon spp*.), as described in Section 9.1.2 of the Navy's NWTT Marine Species Density Database Technical Report (U.S. Department of the Navy, 2020).

Research and observations (see *Behavioral Responses from Explosives*) show that beaked whales are sensitive to human disturbance including noise from sonars, although no research on specific reactions to impulsive sounds or noise from explosions is available. Odontocetes overall have shown little responsiveness to impulsive sounds although it is likely that beaked whales are more reactive than most other odontocetes. Reactions could include alerting, startling, breaking off feeding dives and surfacing, diving or swimming away, change in vocalization, or showing no response at all. Beaked whales on Navy ranges have been observed leaving the area for a few days during sonar training exercises. It is reasonable to expect that animals may leave an area of more intense explosive activity for a few days, however most explosive use during Navy activities is short-duration consisting of only a single or few closely timed explosions (i.e., detonated within a few minutes) with a limited footprint due to a single detonation point. Because noise from most activities using explosives is short-term and intermittent and because detonations usually occur within a small area, behavioral reactions from beaked whales are likely to be short-term and moderate severity.

Impacts from Explosives Under Alternative 1 for Training Activities

Beaked whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training activities for Baird's beaked whale, Cuvier's beaked whale, or the small beaked whale guild (*Mesoplodon spp*.). Impact ranges for these species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be conducted as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of Baird's beaked whale, Cuvier's beaked whale, or the small beaked whale guild (Mesoplodon spp.).

Impacts from Explosives Under Alternative 1 for Testing Activities

Beaked whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for testing activities for Baird's beaked whale, Cuvier's beaked whale, or the small beaked whale guild (*Mesoplodon spp.)*. Impact ranges for these species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 would not result in the incidental taking of Baird's beaked whale, Cuvier's beaked whale, or the small beaked whale guild (Mesoplodon spp.).

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of Baird's beaked whale, Cuvier's beaked whale, or the small beaked whale guild (Mesoplodon spp.).

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts under Alternative 2 from testing with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 would not result in the unintentional taking of Baird's beaked whale, Cuvier's beaked whale, or the small beaked whale guild (Mesoplodon spp.).

Pinnipeds and Mustelids

Pinnipeds include phocid seals (true seals) and otariids (sea lions and fur seals), and mustelids include sea otters.

As described in Section 3.4.2.1.1.5 (Behavioral Reactions), mustelids have similar or reduced hearing capabilities compared to pinnipeds (specifically otariids). Thus, it is reasonable to assume that mustelids use their hearing similarly to that of otariids, and the types of impacts from exposure explosions may also be similar to those described below for pinnipeds, including behavioral reactions, physiological stress, masking, and hearing loss. Additionally, mustelids spend the majority of their time with their heads above the water's surface and live too far inshore to likely be exposed to or impacted by explosions.

If a pinnipeds or mustelid were to experience TTS from explosive sounds, it may have reduced ability to detect biologically important sounds until their hearing recovers. Recovery from TTS begins almost immediately after the noise exposure ceases and can take a few minutes to a few days, depending on the severity of the initial shift, to fully recover. Threshold shifts do not necessarily affect all hearing frequencies equally, and typically manifest themselves at the exposure frequency or within an octave above the exposure frequency. Noise from explosions is broadband with most energy below a few hundred Hertz; therefore, any hearing loss from exposure to explosive sounds is likely to be broadband with effects predominantly at lower frequencies. During the short period that a pinniped had TTS, social calls from conspecifics could be more difficult to detect or interpret; however, most pinniped vocalizations may be above the frequency of TTS induced by an explosion. Killer whales are one of the pinniped primary predators. Killer whale vocalizations are typically above a few kHz, well above the region of hearing that is likely to be affected by exposure to explosive energy. Therefore, TTS in pinnipeds due to sound from explosions is unlikely to reduce detection of killer whale calls. Pinnipeds may use sound underwater to find prey and feed; therefore, a TTS could have a minor and temporary effect on a phocid seal's ability to locate prey.

Research and observations of auditory masking in marine mammals due to impulsive sounds are discussed in Section 3.4.2.2.1.4 (Masking). Explosions introduce low-frequency, broadband sounds into the environment, which could mask hearing thresholds in pinnipeds that are nearby, although sounds from explosions last for only a few seconds at most. Masking due to time-isolated detonations would not be significant. Activities that have multiple detonations such as some naval gunfire exercises could create some masking for pinnipeds in the area over the short duration of the event. Potential costs to pinnipeds and mustelids from masking are similar to those discussed above for TTS, with the primary difference being that the effects of masking are only present when the sound from the explosion is present within the water and the effect is over the moment the sound has ceased.

Research and observations (see Behavioral Responses from Explosives) show that pinnipeds may be the least sensitive taxonomic group to most noise sources. They are likely to only respond to loud impulsive sound sources at close ranges by startling, jumping into the water when hauled out, or even cease foraging, but only for brief periods before returning to their previous behavior. Pinnipeds may even experience TTS before exhibiting a behavioral response (Southall et al., 2007). Because noise from most activities using explosives is short-term and intermittent, and because detonations usually occur within a small area, behavioral reactions from phocid seals are likely to be short-term and low severity.

Physiological stress could be caused by injury or hearing loss and could accompany any behavioral reaction as well. Research and observations of physiological stress in marine mammals are discussed in Section 3.4.2.2.1.3 (Physiological Stress). Due to the short-term and intermittent use of explosives, physiological stress is also likely to be short-term and intermittent. Long-term consequences from physiological stress due to the sound of explosives would not be expected.

California Sea Lions

Impacts from Explosives Under Alternative 1 for Training Activities

California sea lions may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training activities. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

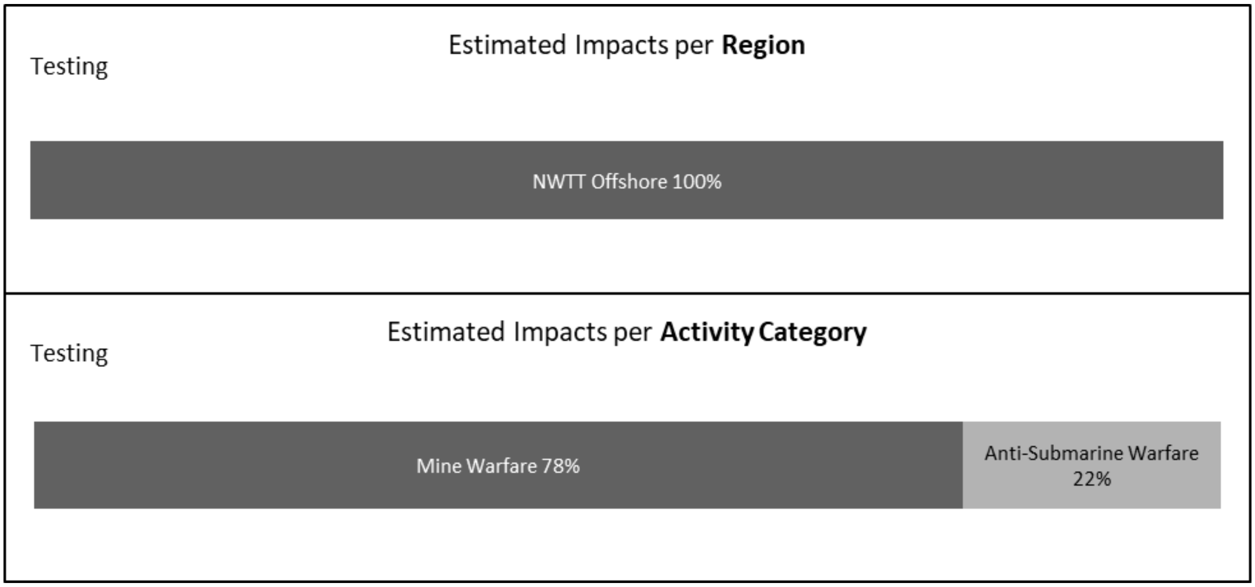
Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of California sea lions.

Impacts from Explosives Under Alternative 1 for Testing Activities

California sea lions may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates behavioral reactions, TTS, PTS (Figure 3.4-86 and Table 3.4-100). Impact ranges for these species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to the U.S. stock (Table 3.4-100).

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking California sea lions incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.



Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-86: California Sea Lion Impacts Estimated per Year from the Maximum Number of Explosions During Testing Under Alternative 1 and Alternative 2

Table 3.4-100: Estimated Impacts on Individual California Sea Lion Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1 and Alternative 2

Estimated Impacts by Effect								
Stock	***Training***				***Testing***			
	Behavioral	***TTS***	***PTS***	***Injury***	***Behavioral***	***TTS***	***PTS***	***Injury***
U.S. Stock	0	0	0	0	1	3	1	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1 and Alternative 2.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of California sea lions.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts on these species under Alternative 2 from testing with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities (see Figure 3.4-86 and Table 3.4-100).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking California sea lions incidental to those activities.

Steller Sea Lions (one DPS is Endangered Species Act-Listed)

The Eastern U.S. stock of Steller sea lions is not listed under the Endangered Species Act. All impacts estimated by the quantitative analysis are on the Eastern U.S. stock. The Western U.S. stock of Steller sea lions is listed endangered under the ESA; however, Steller sea lions from the Western U.S. stock are rare in the Study Area.

Impacts from Explosives Under Alternative 1 for Training Activities

Steller sea lions may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training activities. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of Steller sea lions.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 1 may affect ESA-listed Steller sea lions. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

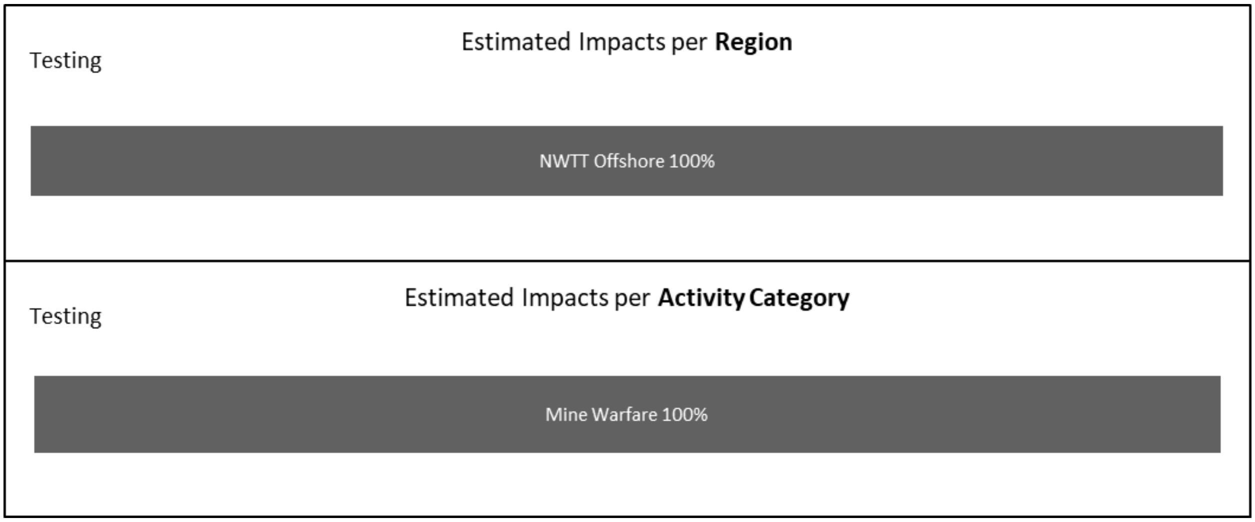
Impacts from Explosives Under Alternative 1 for Testing Activities

Steller sea lions may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates TTS (Figure 3.4-87 and Table 3.4-101). Impact ranges for these species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to the Eastern U.S. stock (Table 3.4-101).

As described above, even a few minor to moderate TTS reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking Steller sea lions incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 1 may affect ESA-listed Steller sea lions. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.



Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-87: Steller Sea Lion Impacts Estimated per Year from the Maximum Number of Explosions During Testing Under Alternative 1 and Alternative 2

Table 3.4-101: Estimated Impacts on Individual Steller Sea Lion Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1 and Alternative 2

Estimated Impacts by Effect								
Stock	***Training***				***Testing***			
	Behavioral	***TTS***	***PTS***	***Injury***	***Behavioral***	***TTS***	***PTS***	***Injury***
Eastern U.S.	0	0	0	0	0	1	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1 and Alternative 2.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of Steller sea lions.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 2 may affect ESA-listed Steller sea lions.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts on these species under Alternative 2 from testing with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities (see Figure 3.4-87 and Table 3.4-101).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking Steller sea lions incidental to those activities.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 2 may affect ESA-listed Steller sea lions.

Guadalupe Fur Seals (Endangered Species Act-listed)

Impacts from Explosives Under Alternative 1 for Training Activities

Guadalupe fur seals are present within the coastal margins of the offshore portion of the Study Area during the warm season (summer and early autumn), where they may be exposed to sound or energy from explosions associated with training activities throughout the year. Training activities involving explosives would be concentrated in the NWTT Offshore Area. Detonations would generally occur greater than 50 NM from shore, outside of these coastal margins. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training activities. Impact ranges for these species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of Guadalupe fur seals.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 1 may affect ESA-listed Guadalupe fur seals. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Impacts from Explosives Under Alternative 1 for Testing Activities

Guadalupe fur seals are present within the coastal margins of the offshore portion of the Study Area during the warm season (summer and early autumn), where they may be exposed to sound or energy from explosions associated with testing activities throughout the year. All testing involving explosives would occur in the Offshore Area, and, with the exception of explosive Mine Countermeasure and Neutralization Testing activities, would typically occur at distances greater than 50 NM from shore. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for testing activities. Impact ranges for these species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 would not result in the incidental taking of Guadalupe fur seals.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 1 may affect ESA-listed Guadalupe fur seals. The Navy has consulted with NMFS as required by Section 7(a)(2) of the ESA.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of Guadalupe fur seals.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 2 may affect ESA-listed Guadalupe fur seals.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts on these species under Alternative 2 from testing with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 would not result in the incidental taking Guadalupe fur seals.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 2 may affect ESA-listed Guadalupe fur seals.

Northern Fur Seals

Impacts from Explosives Under Alternative 1 for Training Activities

Northern fur seals may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for training activities. Impact ranges for these species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of northern fur seals.

Impacts from Explosives Under Alternative 1 for Testing Activities

Northern fur seals may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates no impacts for testing activities. Impact ranges for these species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives).

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 would not result in the incidental taking of Northern fur seals.

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts under Alternative 2 from training with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities. The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of northern fur seals.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts on these species under Alternative 2 from testing with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 would not result in the incidental taking Northern fur seals.

Harbor Seals

Impacts from Explosives Under Alternative 1 for Training Activities

Harbor seals may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates TTS and PTS (Figure 3.4-88 and tabular results in Appendix E, Estimated Marine Mammal and Sea Turtle Impacts from Exposure to Acoustic and Explosive Stressors under Navy Training and Testing Activities). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (Table 3.4-102).

As described above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 will result in the unintentional taking of harbor seals incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Impacts from Explosives Under Alternative 1 for Testing Activities

Harbor seals may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates behavioral reactions, TTS, and PTS (Figure 3.4-88 and Table 3.4-102). Impact ranges for these species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to the Oregon/Washington Coastal stock (Table 3.4-102).

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of harbor seals incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-88: Harbor Seal Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Table 3.4-102: Estimated Impacts on Individual Harbor Seal Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1

Estimated Impacts by Effect								
Stock	***Training***				***Testing***			
	Behavioral	***TTS***	***PTS***	***Injury***	***Behavioral***	***TTS***	***PTS***	***Injury***
Hood Canal	0	4	1	0	0	0	0	0
Oregon/Washington Coastal	0	0	0	0	9	11	2	0
Southeast Alaska - Clarence Strait	0	0	0	0	0	0	0	0
Southern Puget Sound	0	0	0	0	0	0	0	0
Washington Northern Inland Waters	0	30	5	0	0	0	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Explosives Under Alternative 2 for Training Activities

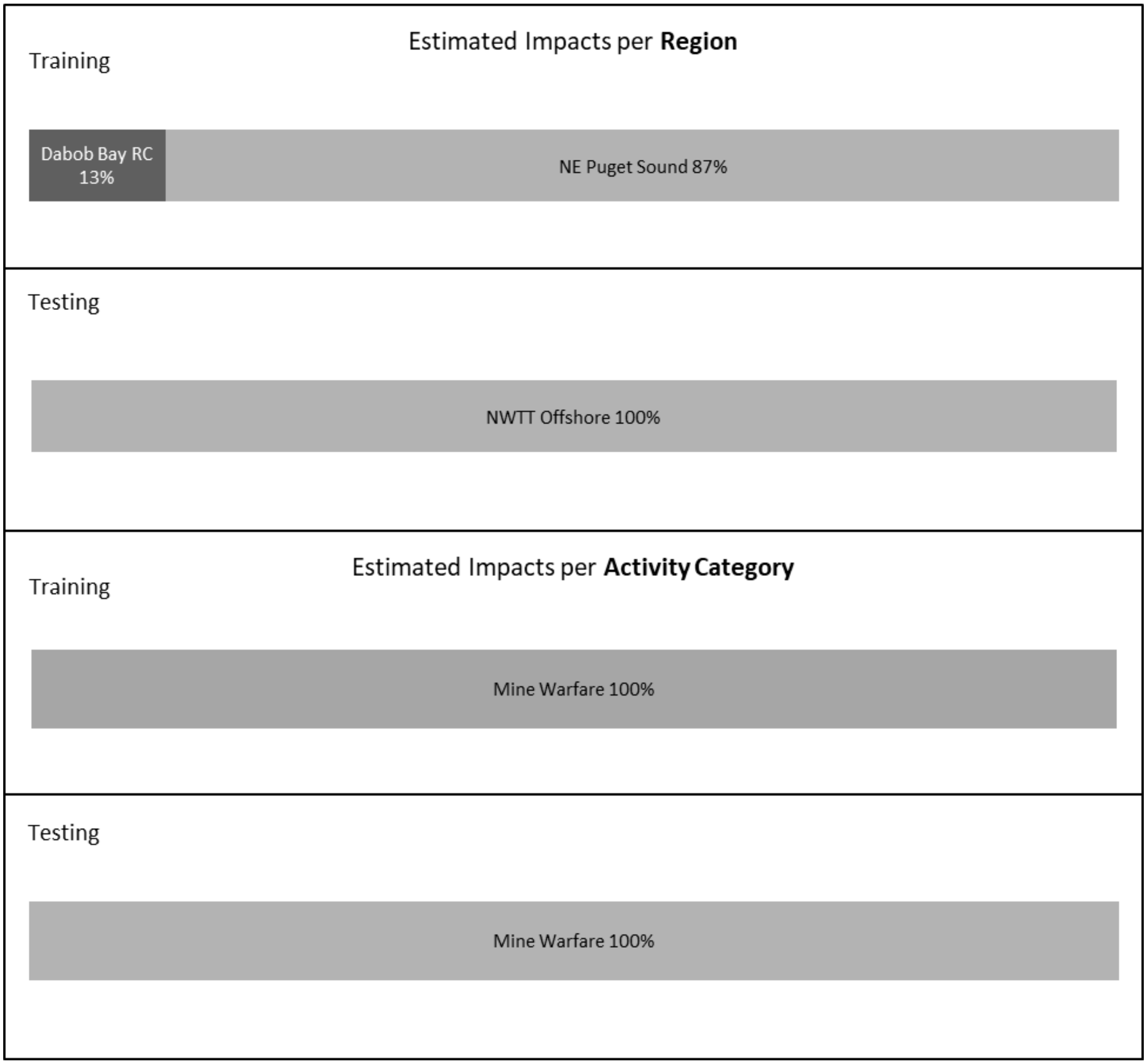
Potential annual impacts under Alternative 2 from training with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities (see Table 3.4-103). The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of harbor seals incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts on these species under Alternative 2 from testing with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities (Figure 3.4-89 and Table 3.4-103).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking harbor seals incidental to those activities.



Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-89: Harbor Seal Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 2

Table 3.4-103: Estimated Impacts on Individual Harbor Seal Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 2

Estimated Impacts by Effect								
Stock	***Training***				***Testing***			
	Behavioral	***TTS***	***PTS***	***Injury***	***Behavioral***	***TTS***	***PTS***	***Injury***
Hood Canal	0	7	1	0	0	0	0	0
Oregon/Washington Coastal	0	0	0	0	9	11	2	0
Southeast Alaska - Clarence Strait	0	0	0	0	0	0	0	0
Southern Puget Sound	0	0	0	0	0	0	0	0
Washington Northern Inland Waters	0	50	8	0	0	0	0	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Northern Elephant Seals

Impacts from Explosives Under Alternative 1 for Training Activities

Northern elephant seals may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates TTS and PTS (Figure 3.4-90 and Table 3.4-104). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to the California stock (Table 3.4-104).

As described above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 will result in the unintentional taking of northern elephant seals incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Impacts from Explosives Under Alternative 1 for Testing Activities

Northern elephant seals may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates behavioral reactions, TTS, and PTS (Figure 3.4-90 and Table 3.4-104).

Impact ranges for these species are discussed in Section 3.4.2.2.2.2 (Impact Ranges for Explosives). Estimated impacts apply to the California stock (Table 3.4-104).

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of Northern elephant seals incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-90: Northern Elephant Seal Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Table 3.4-104: Estimated Impacts on Individual Northern Elephant Seal Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1

Stock	Training				Testing			
	Behavioral	*TTS*	*PTS*	*Injury*	*Behavioral*	*TTS*	*PTS*	*Injury*
California	0	2	1	0	7	8	3	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 1.

Impacts from Explosives Under Alternative 2 for Training Activities

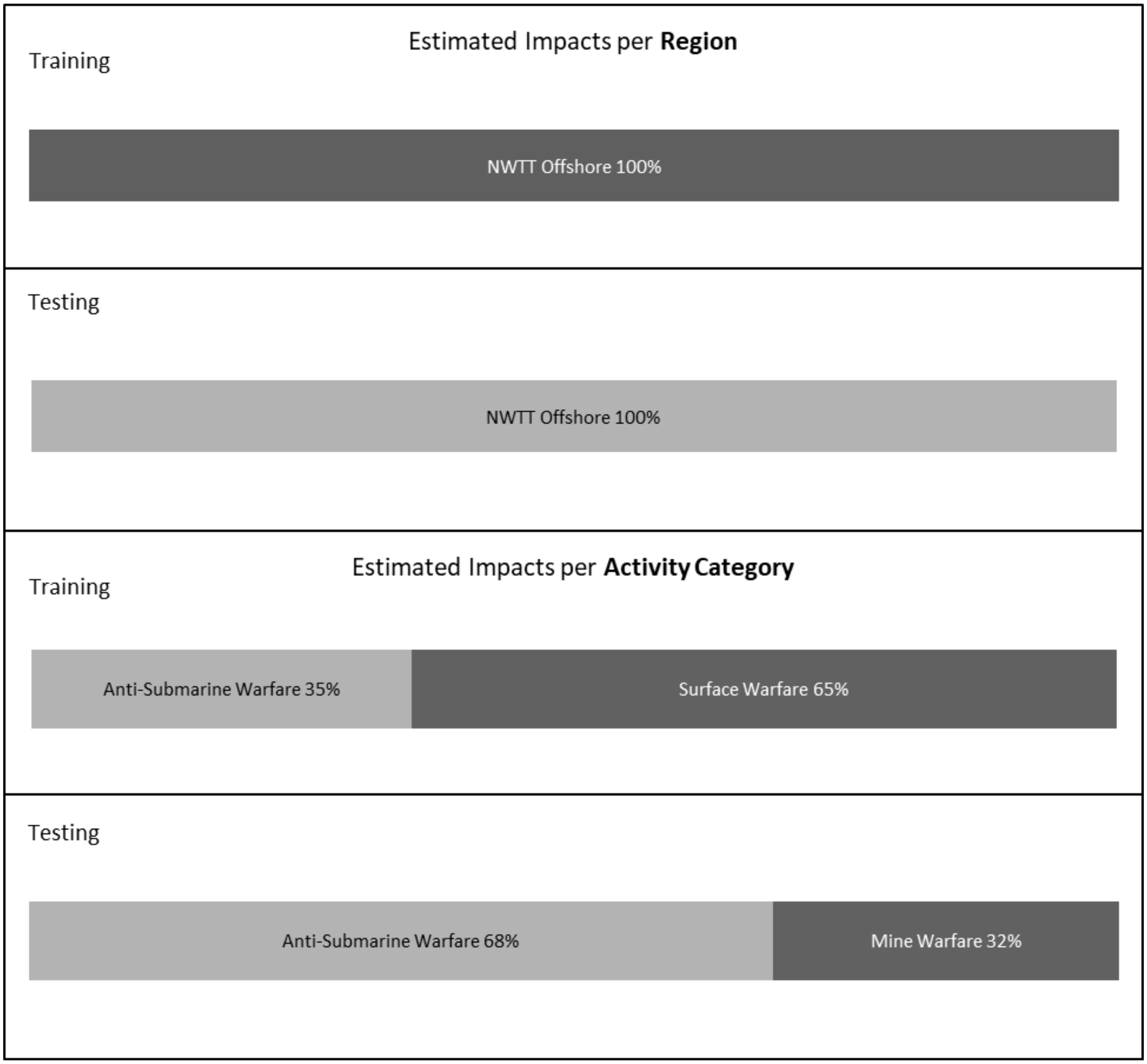
Potential annual impacts under Alternative 2 from training with explosives would be similar to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Training Activities (Figure 3.4-91 and Table 3.4-105). The primary distinction is that explosive use would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the potential for impacts from training under Alternative 2 may increase slightly based on the slight increase in explosive use compared to Alternative 1.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of northern elephant seals incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

Annual explosive use during testing activities under Alternative 2 would be identical to annual explosive use under Alternative 1. Therefore, potential annual impacts on these species under Alternative 2 from testing with explosives would be identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities (Figure 3.4-91 and Table 3.4-105).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking Northern elephant seals incidental to those activities.



Notes: Region and Activity Category bar charts show categories +/- 0.5 percent of the estimated impacts, which could result in a total of 98–101 percent. Estimated impacts most years would be less based on fewer explosions. The model is probabilistic, and therefore a single impact could be divided among multiple regions or activity categories.

Figure 3.4-91: Northern Elephant Seal Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 2

Table 3.4-105: Estimated Impacts on Individual Northern Elephant Seal Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 2

Estimated Impacts by Effect								
Stock	*Training*				*Testing*			
	Behavioral	*TTS*	*PTS*	*Injury*	*Behavioral*	*TTS*	*PTS*	*Injury*
California	0	5	2	0	7	8	3	0

Note: Estimated impacts are based on the maximum number of activities in a given year under Alternative 2.

Northern Sea Otters

Sea otters that occur along the coast of Washington are the result of reintroduction efforts of the northern sea otter (from Amchitka Island, Alaska) in 1969 and 1970 (Lance et al., 2004; Sato, 2018), and are not listed as threatened or endangered under the ESA (Carretta et al., 2017c). There is a single stock in Washington waters (the northern sea otter [*Enhydra lutris kenyoni*]) and a single stock in California (the southern sea otter [*Enhydra lutris nereis*]). Only the Washington stock of sea otter is known to occur in the Study Area (Carretta et al., 2017c) and is expected to only be present in the shallow, nearshore areas of the Offshore portion of the Study Area.

Sea otters seldom range more than 2 km from shore, because they are benthic foragers and limited by their ability to dive to the seafloor; although some individuals, particularly juvenile males, may travel farther offshore (Calambokidis et al., 1987; Laidre et al., 2009; Muto et al., 2017; Riedman & Estes, 1990). (Ghoul & Reichmuth, 2014b) have shown that sea otters are not especially well adapted for hearing underwater, which suggests that the function of this sense has been less important in their survival and evolution than in comparison to pinnipeds. Sea otters in this region are mainly concentrated off the coast of the Olympic Peninsula and the western Strait of Juan de Fuca, with only rare sightings in Puget Sound. Sea otters do not typically occur in Inland Waters, thus activities occurring in these areas would not overlap with sea otter presence.

Impacts from Explosives Under Alternative 1 for Training Activities

Northern sea otters would likely not be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis predicts no impacts to sea otters under Alternative 1. Sea otters primarily inhabit shallow coastal areas and spend the majority of their time floating at the surface with their ears above the water. Training activities involving explosives would be concentrated in the NWTT Offshore Area. Detonations would generally occur greater than 50 NM from shore, far from the nearshore areas that sea otters inhabit. Thus, impacts are highly unlikely due to limited use of explosives nearshore and the unlikely occurrence of sea otters overlapping with explosions during training activities.

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 would not result in the incidental taking of Northern sea otters.

Impacts from Explosives Under Alternative 1 for Testing Activities

Northern sea otters would likely not be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis predicts no impacts to sea otters under Alternative 1. Sea otters primarily inhabit shallow coastal areas and spend the majority of their time floating at the surface with their ears above the water. All testing involving explosives would occur in the Offshore Area, and, with the exception of explosive Mine Countermeasure and Neutralization Testing activities, would typically occur at distances greater than 50 NM from shore. Still, the distance from mine countermeasure and neutralization testing area to sea otter habitat would greatly exceeds the range to potential behavioral impacts estimated for the largest explosive proposed for these activities. Thus, impacts are highly unlikely due to the ranges to impacts and the unlikely occurrence of sea otters overlapping with explosions during testing activities.

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 would not result in the incidental taking of Northern sea otters.

Impacts from Explosives Under Alternative 2 for Training Activities

Northern sea otters would likely not be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis predicts no impacts to sea otters under Alternative 2. Sea otters primarily inhabit shallow coastal areas and spend the majority of their time floating at the surface with their ears above the water. Training activities involving explosives would be concentrated in the NWTT Offshore Area. Detonations would generally occur greater than 50 NM from shore, far from the nearshore areas that sea otters inhabit. Thus, impacts are highly unlikely due to limited use of explosives nearshore and the unlikely occurrence of sea otters overlapping with explosions during training activities.

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 would not result in the incidental taking of Northern sea otters.

Impacts from Explosives Under Alternative 2 for Testing Activities

Testing activities with explosives is identical under Alternative 1 and Alternative 2; therefore, the locations, types, and severity of predicted impacts would be the same.

Considering these factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 would not result in the incidental taking of Northern sea otters.

3.4.2.2.2.4 Impacts from Explosives Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct proposed at-sea training and testing activities in the Study Area. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities. Discontinuing the training and testing activities would result in fewer explosive stressors within the marine environment where Navy activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would remove the potential for explosive impacts on marine mammals, but would not measurably improve the overall distribution or abundance of marine mammals.

3.4.2.3 Energy Stressors

The energy stressors that may impact marine mammals include in-water electromagnetic devices and high-energy lasers. Only one new energy stressor (high-energy lasers) used in testing activities differs from the energy stressors that were previously analyzed in the 2015 NWTT Final EIS/OEIS. Use of low-energy lasers and in-air electromagnetic devices were analyzed and dismissed as energy stressors in the 2015 NWTT Final EIS/OEIS in Section 3.0.5.3.2.2 (Lasers) and Section 3.0.5.3.2.1 (Electromagnetic – Airborne Electromagnetic Energy). However, at that time high-energy laser weapons were not part of the Proposed Action for the Study Area. (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a, 2015b).

3.4.2.3.1 Impacts from In-Water Electromagnetic Devices

For the 2015 analysis of in-water electromagnetic devices as energy stressors, see Section 3.4.3.3 (Energy Stressors) in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a). Since the 2015 NWTT Final EIS/OEIS, and with the increased use of undersea power cables associated with offshore energy generation, there has been renewed scientific interest in electromagnetic fields possibly affecting migrating marine mammals (Driessen et al., 2020; Gill et al., 2014; Kremers et al., 2016; Kremers et al., 2014; Zellar et al., 2017). Recently reported analysis of empirical observation of humpback whale migrations has suggested that the migratory decisions for the species are relatively insensitive to changing oceanographic and geomagnetic conditions (Horton et al., 2017; Horton et al., 2020). These additional scientific findings do not change in any way the rationale for the dismissal of in-water electromagnetic devices as presented in the 2015 analyses. As presented and at the most basic level, the Navy does not anticipate any impacts from the use of in-water electromagnetic devices because the electromagnetic field is the simulation of a ship's magnetic field, having no greater impact than that of a passing ship. The number and location of activities using in-water electromagnetic devices would not change under this Supplemental from the ongoing activities. The analyses presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) remain valid; impacts to marine mammals from the use of in-water electromagnetic devices are not expected.

3.4.2.3.1.1 Impacts from In-Water Electromagnetic Devices Under Alternative 1

<u>Impacts from In-Water Electromagnetic Devices Under Alternative 1 for Training Activities</u>

Under Alternative 1, the number of proposed training activities involving the use of in-water electromagnetic devices is the same as presented in the 2015 NWTT Final EIS/OEIS (see Table 3.0-9). These activities would occur in the same Inland Waters locations and same manner as previously analyzed. Therefore, as stated in the 2015 NWTT Final EIS/OEIS and based on the new science summarized above, the impact of in-water electromagnetic devices on marine mammals is not expected.

The use of in-water electromagnetic devices during training activities as described under Alternative 1 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of in-water electromagnetic devices during training activities, as described under Alternative 1, may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA. The use of in-water electromagnetic devices would have no effect on humpback whale proposed critical habitat and Southern Resident killer whale existing critical habitat or proposed critical habitat.

<u>Impacts from In-Water Electromagnetic Devices Under Alternative 1 for Testing Activities</u>

Under Alternative 1 and as shown in Table 3.0-9, there are no testing events involving the use of in-water electromagnetic devices.

3.4.2.3.1.2 Impacts from In-Water Electromagnetic Devices Under Alternative 2

<u>Impacts from In-Water Electromagnetic Devices Under Alternative 2 for Training Activities</u>

Under Alternative 2, the number of proposed training activities involving the use of in-water electromagnetic devices is the same as presented in the 2015 NWT Final EIS/OEIS (see Table 3.0-9) and the same as under Alternative 1. As presented under Alternative 1, the impact of in-water electromagnetic devices on marine mammals is not expected.

The use of in-water electromagnetic devices during training activities as described under Alternative 2 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of in-water electromagnetic devices during training activities, as described under Alternative 2, may affect ESA-listed marine mammals. The use of in-water electromagnetic devices would have no effect on humpback whale proposed critical habitat and Southern Resident killer whale existing critical habitat or proposed critical habitat.

<u>Impacts from In-Water Electromagnetic Devices Under Alternative 2 for Testing Activities</u>

Under Alternative 2 and as shown in Table 3.0-9, there are no testing events involving the use of in-water electromagnetic devices.

3.4.2.3.1.3 Impacts from In-Water Electromagnetic Devices Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct proposed at-sea training and testing activities in the Study Area. In-water electromagnetic devices as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer energy stressors within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for impacts from in-water electromagnetic devices on individual marine mammals, but would not measurably improve the status of marine mammal populations or subpopulations.

3.4.2.3.2 Impacts from High-Energy Lasers

As described in Section 3.0.3.3.2.2 (High-Energy Lasers) of this Supplemental, the high-energy lasers analyzed in this section include weapons testing activities that involve evaluating the effectiveness of a high-energy laser weapon deployed from a surface ship or helicopter to create small but critical failures in potential targets from short ranges.

The primary concern is the potential for a marine mammal to be exposed to the laser beam at or near the water's surface, which could result in injury or death. However, marine mammals could only be exposed if the laser beam missed the target. The potential for marine mammals to be directly hit by a high-energy laser beam that missed the target was evaluated using statistical probability modeling (Appendix F, Military Expended Material and Direct Strike Impact Analyses) to estimate the potential direct strike exposures to a marine mammal for a worst-case scenario. Model input values include high-energy laser use data (e.g., number of high-energy laser weapon exercises and laser beam footprint), size of the testing area, marine mammal density data, and animal cross-sectional area. To estimate the probability of hitting a marine mammal in a worst-case scenario (based on assumptions listed below), the impact area for all laser testing events was summed over one year in the Offshore portion of the Study Area under each alternative. Finally, the marine mammal species with the highest average seasonal density within the Offshore area was used in the analysis. This approach ensures that all other species with a lower density would have a lower probability of being struck by a laser missing the target.

Within the statistical probability model, the estimated potential for a marine mammal strike is influenced by the following assumptions:

- The model is two-dimensional and assumes that all animals would be at or near the surface 100 percent of the time, when in fact marine mammals spend up to 90 percent of their time under the water (Costa, 1993).
- The model assumes the animal is stationary and does not account for any movement of the marine mammal or any potential avoidance of the testing activity.

3.4.2.3.2.1 Impacts from High-Energy Lasers Under Alternative 1

Impacts from High-Energy Lasers Under Alternative 1 for Training Activities

High-energy laser weapons would not be used during training activities under Alternative 1, so there would be no impacts.

Impacts from High-Energy Lasers Under Alternative 1 for Testing Activities

As discussed in Section 3.0.3.3.2.2 (High-Energy Lasers) and shown in Table 3.0-10, under Alternative 1 there would be up to 55 testing activities per year involving the use of high-energy lasers. One of those 55 activities is a test of a laser-based optical communication system, which was discussed in Section 3.0.3.3.2.2 and dismissed from further evaluation. The remaining 54 annual testing activities would involve the use of high-energy laser weapons in the Offshore portion of the Study Area.

The marine mammal species with the highest average seasonal density in the Offshore portion of the Study Area (Dall's porpoise) was used in the statistical probability analysis presented in Appendix F (Military Expended Material and Direct Strike Impact Analyses). Based on the probability analysis in Appendix F, the results indicate that no Dall's porpoise would be struck by a high-energy laser in the course of a year. Considering the assumptions outlined above, there is a high level of certainty in the conclusion that no marine mammals that occur in the Study Area would be struck by a high-energy laser.

The use of high-energy laser weapons during testing activities as described under Alternative 1 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of high-energy laser weapons during testing activities, as described under Alternative 1, may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA. The use of high-energy laser weapons would have no effect on humpback whale proposed critical habitat and Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.3.2.2 Impacts from High-Energy Laser Weapons Under Alternative 2

Impacts from High-Energy Lasers Under Alternative 2 for Training Activities

High-energy laser weapons would not be used during training activities under Alternative 2, so there would be no impacts.

Impacts from High-Energy Lasers Under Alternative 2 for Testing Activities

As discussed in Section 3.0.3.3.2.2 (High-Energy Lasers) and presented in Table 3.0-10, the location, number of testing activities, and potential effects associated with high-energy laser weapons use would be the same under Alternatives 1 and 2. Refer to Section 3.4.2.3.2.1 (Impacts from High-Energy Lasers Under Alternative 1) for a discussion of impacts on marine mammals associated with high-energy laser use.

The use of high-energy laser weapons during testing activities as described under Alternative 2 would not result in the incidental taking of marine mammal.

Pursuant to the ESA, the use of high-energy laser weapons during testing activities, as described under Alternative 2, may affect ESA-listed marine mammals and would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.3.2.3 Impacts from High-Energy Lasers Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct proposed at-sea training and testing activities in the Study Area. High-energy laser weapons as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would remain unchanged.

3.4.2.4 Physical Disturbance and Strike Stressors

The physical disturbance and strike stressors that may impact marine mammals include (1) vessels and in-water devices, (2) military expended materials, and (3) seafloor devices. The annual number of activities including vessels and in-water devices, the annual number of military expended materials, and the annual number of activities including seafloor devices are shown in Tables 3.0-12 through 3.0-18.

3.4.2.4.1 Impacts from Vessel and In-Water Devices

The Navy did not request authorization under MMPA or ESA for take of a marine mammal as a result of vessel or in-water device strike in the 2015 NWTT Final EIS/OEIS. Since the analysis presented in the 2015 NWTT Final EIS/OEIS, there have been new scientific findings made available regarding acute and chronic disturbance to cetaceans and pinnipeds as a result of vessel use. Unlike civilian vessel uses found to be sources of acute and chronic disturbance (see, for example, New et al. (2020); Dwyer et al. (2020)), Navy vessels do not purposefully approach marine mammals or conduct repeated and frequent transits through enclosed bodies of water and near shorelines to view marine mammals. As a result, Navy vessel use in the Study Area does not equate with the types of focused, frequent, and numerous vessels present or transiting a given area that studies have found constitute acute and chronic disturbance to marine mammals. For discussion of physical disturbance from vessels and in water devices, see Section 3.4.2.1.1.3 (Physiological Stress); for vessel noise, see Section 3.4.2.1.3 (Impacts from Vessel Noise); and for behavioral reactions to vessels see Section 3.4.2.1.1.5 (Behavioral Reactions – Behavioral Reactions to Vessels).

Reviews of the literature on vessel strikes mainly involve collisions between commercial vessels and whales (Cascadia Research, 2017b; Currie et al., 2017a; Douglas et al., 2008; Greig et al., 2020; Jensen & Silber, 2004; Keen et al., 2019; Laist et al., 2001; Lammers et al., 2013; Monnahan et al., 2015; Nichol et al., 2017; Redfern et al., 2020; Rockwood et al., 2017). The ability of any ship to detect a marine mammal and avoid a collision depends on a variety of factors, including environmental conditions, ship design, size, speed, and manning, as well as the behavior of the animal (Calambokidis et al., 2019; Conn & Silber, 2013; Currie et al., 2017a; Gende et al., 2011; Keen et al., 2019; Silber et al., 2010; Vanderlaan & Taggart, 2007; Wiley et al., 2016). In areas of both high whale density and a high volume of vessel traffic, such as the Strait of Juan de Fuca and its entrance, whales are predicted to be susceptible to elevated risk for vessel strike (Keen et al., 2019; Nichol et al., 2017).

Large Navy vessels (greater than 18 m in length) within the offshore areas of the Study Area operate differently from commercial vessels in ways important to the prevention of whale collisions. For example, the average speed of large Navy ships ranges between 10 and 15 knots, and submarines generally operate at speeds in the range of 8 and 13 knots, while a few specialized vessels can travel at faster speeds. By comparison, this is slower than most commercial vessels where normal design speed for a container ship is typically 24 knots (Bonney & Leach, 2010). Even given the advent of "slow steaming" by commercial vessels in recent years due to fuel prices (Barnard, 2016; Maloni et al., 2013), this generally reduces the design speed by only a few knots, given that 21 knots would be considered slow, 18 knots is considered "extra slow," and 15 knots is considered "super slow" (Bonney & Leach, 2010). Small Navy craft (less than 50 ft. in length), have much more variable speeds (0–50 knots or more, depending on the mission). While these speeds are considered averages and representative of most events, some Navy vessels need to operate outside of these parameters during certain situations. Differences between most Navy ships and commercial ships also include the following disparities:

- The Navy has several standard operating procedures for vessel safety that could result in a secondary benefit to marine mammals through a reduction in the potential for vessel strike, as discussed in the 2015 NWTT Final EIS/OEIS Section 5.1.2 (Vessel Safety). For example, ships operated by or for the Navy have personnel assigned to stand watch at all times, day and night, when moving through the water (i.e., when the vessel is underway). Watch personnel undertake extensive training in accordance with the U.S. Navy Lookout Training Handbook or civilian equivalent. A primary duty of watch personnel is to ensure safety of the ship, which includes the requirement to detect and report all objects and disturbances sighted in the water that may be indicative of a threat to the ship and its crew, such as debris, a periscope, surfaced submarine, or surface disturbance. Per safety requirements, watch personnel also report any marine mammals sighted that have the potential to be in the direct path of the ship, as a standard collision avoidance procedure. As described in Section 5.3.4.1 (Vessel Movement) of this Supplemental, Navy vessels are required to operate in accordance with applicable navigation rules. Applicable rules include the Inland Navigation Rules (33 Code of Federal Regulations 83) and International Regulations for Preventing Collisions at Sea (72 Collision Regulations), which were formalized in the Convention on the International Regulations for Preventing Collisions at Sea, 1972. These rules require that vessels proceed at a safe speed so proper and effective action can be taken to avoid collision and so vessels can be stopped within a distance appropriate to the prevailing circumstances and conditions. In addition to complying with navigation requirements, Navy ships transit at speeds that are optimal for fuel conservation, to maintain ship schedules, and to meet mission requirements. Vessel captains use the totality of the circumstances to ensure the vessel is traveling at appropriate speeds in accordance with navigation rules. Depending on the circumstances, this may involve adjusting speeds during periods of reduced visibility or in certain locations.

- Many Navy ships have their bridges positioned closer to the bow, offering good visibility ahead of the ship.
- There are often aircraft associated with the training or testing activity, which can detect marine mammals in the vicinity or ahead of a vessel's present course.
- Navy ships are generally much more maneuverable than commercial merchant vessels if marine mammals are spotted and it becomes necessary to change direction.
- Navy ships operate at the slowest speed possible consistent with either transit needs, or training or testing need. While minimum speed is intended as a fuel conservation measure particular to a certain ship class, secondary benefits include being better able to spot and avoid objects in the water, including marine mammals.
- In many cases, Navy ships will likely move randomly or with a specific pattern within a sub-area of the Study Area for a period of time, from one day to two weeks, as compared to straight line point-to-point commercial shipping.
- Navy overall crew size is much larger than merchant ships, allowing for more potential observers on the bridge.
- When submerged, submarines are generally slow moving (to avoid detection), and therefore marine mammals at depth with a submarine are likely able to avoid collision with the submarine. When a submarine is transiting on the surface, there are Lookouts serving the same function as they do on surface ships.
- The Navy will implement mitigation to avoid potential impacts from vessel strikes on marine mammals (see Chapter 5, Mitigation). Mitigation includes training Lookouts and watch personnel with the Marine Species Awareness Training (which provides information on sighting cues, visual observation tools and techniques, and sighting notification procedures), requiring vessels to maneuver to maintain a specified distance from marine mammals during vessel movements.

Data from the ports of Vancouver, British Columbia; Seattle, Washington; and Tacoma, Washington indicated there were in excess of 7,000 commercial vessel transits in 2017 associated with visits to just those ports (The Northwest Seaport Alliance, 2018; Vancouver Fraser Port Authority, 2017). This number of vessel transits in inland waters does not account for other vessel traffic in the Strait of Juan de Fuca or Puget Sound resulting from commercial ferries, tourist vessels, or recreational vessels. For example, Van Dorp and Merrick (2017) report that the U.S. Coast Guard Vessel Traffic Service handles approximately 230,000 transits annually with about 170,000 of those being Washington State Ferries. Additional commercial traffic in the Study Area also includes vessels transiting offshore along the Pacific coast, bypassing ports in Canada and Washington; traffic associated with ports to the south along the coast of

Washington and in Oregon; and vessel traffic in Southeast Alaska (Nuka Research & Planning Group, 2012). This level of commercial vessel traffic for the ports of Vancouver, Seattle, and Tacoma is approximately the same as was presented in the 2015 NWTT Final EIS/OEIS.

In the Study Area, the existing marine environment is dominated by non-Navy vessel traffic given the Navy has, in total, the following homeported operational vessels: 2 aircraft carriers, 7 destroyers, 14 submarines, and 22 smaller security vessels. Appendix A (Navy Activities Descriptions) describes the number of vessels used during the various types of Navy's proposed activities. Activities involving Navy vessel movement would be widely dispersed throughout the Study Area.

Many marine mammals in the Study Area (especially large whales) have seasonal ranges that include the remainder of the U.S. West Coast, Hawaii, and Alaska (beyond the Behm Canal portion of the Study Area). Between 1986 and 2017, there have been 12 fin whales killed as a result of vessel strikes found in the Inland Waters portion of the Study Area (Towers et al., 2018b). For the latest five-year reporting periods, NMFS Technical Memoranda documented 65 vessel strikes to marine mammals off the U.S West Coast (Washington, Oregon, and California) (Carretta et al., 2019a), 38 vessel strikes to humpback whales in Hawaii (Bradford & Lyman, 2015), and approximately 28 vessel strikes to marine mammals in Alaska (Helker et al., 2019); there were no Navy vessel strikes to marine mammals in this period. For large whale along just the U.S. West Coast between 2013 and 2017, the 24 known commercial strikes involved 1 Baird's beaked whale, 8 fin whales, 1 sei whale, 14 humpback whales, and 7 gray whales (Carretta et al., 2019a). The most recent NMFS database covering strandings in Washington and Oregon indicates that between 2000 and 2016, there were 18 known cases of whales struck by vessels presumably in the adjacent waters (National Marine Fisheries Service, 2017a). For the most recent NMFS database covering ship strikes off California, there were 14 known vessel strikes in 2018 and 11 strikes (up to June 2) in 2019 (National Marine Fisheries Service, 2019c).

Navy policy (Chief of Naval Operations Instruction F3100.6 J) is to report all whale strikes by Navy vessels. By information agreement, that information has been provided to NMFS on an annual basis. Only the Navy and the U.S. Coast Guard report vessel strike to NMFS in this manner, so all statistics are skewed by a lack of comprehensive reporting by all vessels that may experience vessel strike.

Vessel strike records from the Navy have been kept since 1995. There has been a total of two vessel strikes to marine mammals in the NWTT Study Area associated with Navy activities (one in 2012 and one in 2016), up to and through the date of publication for the NWTT Final Supplemental EIS/OEIS (August 2020).

The fate of the two whales that were struck by Navy vessels in the Study Area is unknown. Although it does not preclude the possibility that a serious injury or mortality may have occurred, in neither of these two cases were there indications of serious injuries; there was no blood in the water, the whales did not appear injured, and there were no whale strandings or mortalities reported within an associated time frame in the Study Area. For purposes of the analysis in this Supplemental, it is assumed that any whale struck by any vessel would have sustained serious injury or mortality, although evidence of whales displaying diagnostic but healed injuries and scars indicates that some whales struck by a vessel do survive, dependent on a variety of factors (Bradford & Lyman, 2015; Carretta et al., 2019a; Carretta et al., 2017b; Fulling et al., 2017; Helker et al., 2017; Ritter, 2012; Rockwood et al., 2017; Towers et al., 2018b; Van Waerebeek et al., 2007).

The projected Navy vessel use has not significantly changed over time and is not projected to significantly change under the proposed alternatives. Integration of the Navy's Marine Species

Awareness Training began in 2006 and was fully integrated across the Navy by 2009, resulting in a decrease in strike incidents Navy-wide. These factors and adaptation of additional mitigation measures since 2009 makes the period since 2009 the most appropriate for calculation of future expected strikes; while the Navy does not anticipate vessel strikes to marine mammals within the NWTT Study Area during the proposed activities, Navy vessel strikes in the Study Area for the period between 2009 and 2018 can be used to determine a statistical probability of future Navy vessel strike as a rate parameter of a Poisson distribution. To estimate the probability of 0, 1, 2, 3,… n vessel strikes involving Navy vessels over the time period considered in this Supplemental, a simple computation can be generated: $P(X) = P(X\text{-}1)\mu/X$, where $P(X)$ is the probability of occurrence in a unit of time (or space) and μ is the number of occurrences in a unit of time (or space). For the 10-year period from 2009 through 2018, there were 849 Navy vessel steaming days; if μ is based on two strikes over 10 years (2/849=0.002355) then μ = 0.002355. Plugging 0.002355 into the $P(0) = e\text{-}\mu$ yields a value of P(0)=0.002355 strikes per day and estimated probability of 1.36 Navy vessel strikes over a seven-year period in NWTT. As shown in Table 3.4-106, within the seven-year period of time considered in this Supplemental, there is approximately a 26 percent probability that no Navy vessel strikes will occur, a 35 percent chance one strike would occur, a 24 percent chance of two strikes, an 11 percent chance of three strikes occurring, and a 4 percent chance of four strikes occurring.

Table 3.4-106: Poisson Probability of Striking "X" Number of Whales When Expecting 1.36 Total Strikes over a 7-year Period in the NWTT Study Area

Predicted Number of Strikes over a 7-year Period	
No strikes	26%
1 strike	35%
2 strikes	24%
3 strikes	11%
4 strikes	4%

As indicated in Section 3.0.3.4.2 (Vessels), most Navy activities involve the use of vessels. These activities could be widely dispersed throughout the Study Area and the year. Under the two action alternatives in NWTT EIS/OEIS, there would be no appreciable changes from the frequency and manner in which the Navy has operated vessels, and the range of variability observed over the last decade would remain consistent. Consequently, the Navy is not significantly changing the locations or frequency at which vessels are used and therefore does not anticipate a change in the number of strikes expected to occur. The difference in the number of events between Alternative 1 and Alternative 2 is described in Section 3.0.3.4.2 (Vessels) and is not likely to change the low probability of a vessel strike occurrence in any meaningful way.

There has been no significant development since the 2015 NWTT Final EIS/OEIS with regard to the potential for physical disturbance from in-water devices such as torpedoes or unmanned surface or submerged vehicles. For a discussion on the types of activities that use in-water devices see Appendix B (Activity Stressor Matrices), and for where they are used and how many events would occur under each alternative, see Section 3.0.3.4.3 (In-Water Devices) and Table 3.0-13. As presented in the 2015 NWTT Final EIS/OEIS (Section 3.4.3.4.2, Impacts from In-water Device Strikes), there have been no recorded or known instances of a marine species strike by a torpedo or any other Navy in-water device at any location in the world before 2015, and there have been none since. For this reason, physical disturbance and strike impacts from in-water devices are not expected.

Consistent with analysis in the 2015 NWTT Final EIS/OEIS and the action alternatives in this Supplemental as shown in Tables 3.0-12 and 3.0-13, none of the action alternatives have any appreciable changes in locations or frequency of Navy vessel or in-water device use. Although Navy vessel and in-water device use varies based on military missions and combat operations (e.g., world crisis, disaster relief, humanitarian assistance), planned and unplanned deployment vessel and in-water device availability due to maintenance, and funding and logistic concerns, future vessel and in-water device use in the Study Area is projected to remain within the range of variability observed over the last decade.

3.4.2.4.1.1 Impacts from Vessels and In-Water Devices Under Alternative 1 for Vessel Movement

Under Alternative 1 and as shown in Tables 3.0-12 and 3.0-13, use of vessels and in-water devices will increase over the ongoing levels of activity in the Offshore and Inland Waters portions of the Study Area, but decrease in Behm Canal. Based on the analysis presented above, and the assumption that the populations for large whales in the NWTT Study Area are most likely to continue to increase as has generally been the trend in the recent past, the Navy is seeking authorization for a take to account for the possibility of an accidental strike and the potential risk associated with any military vessel movement within the Study Area. There has never been a Navy vessel strike involving any marine mammals other than species considered large whales, and in the most recent regulations issued for activities in the Pacific, NMFS considered a vessel strike to dolphins, small whales, porpoises, and pinnipeds very unlikely (83 FR 66943, 27 December 2018). Based on the analysis presented in Table 3.4-106, there is a low likelihood of four vessel strikes to large whales occurring over a seven-year period; only a 4 percent chance. Therefore, Navy will request authorization for mortality or serious injury from vessel strike over the seven-year period provided in this analysis for three ship strike takes to large whales. In discussions with NMFS as a cooperating agency, it has been determined that of those three whales over the seven-year period, no more than two may come from any of the following species/stocks: fin whale (either the Northeast Pacific or CA/OR/WA stock) and humpback whale (either the Central North Pacific [Hawaii DPS] or CA/OR/WA stock [the Mexico DPS or the Central America DPS]). Additionally, of those three whales over the seven years, no more than one may come from any of the following species/stocks: sperm whale (CA/OR/WA stock), minke whale (CA/OR/WA stock), and gray whale (Eastern North Pacific stock and DPS). The Navy is not requesting ship strike takes to blue whales (Eastern North Pacific stock), minke whales (Alaska stock), gray whale (Western North Pacific stock and DPS), or sei whales (Eastern North Pacific stock).

The use of vessels and in-water devices as described under Alternative 1 may result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of vessels and in-water devices, as described under Alternative 1, may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA. The use of vessels and in-water devices would have no effect on humpback whale proposed critical habitat and Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.4.1.2 Impacts from Vessels and In-Water Devices Under Alternative 2 for Vessel Movement

Under Alternative 2 and as shown in Tables 3.0-12 and 3.0-13, the proposed use of vessels and in-water devices will increase over Alternative 1 and ongoing levels of activity in the Offshore and Inland Waters portions of the Study Area, but decrease in Behm Canal. There would be no meaningful difference in the use of vessels and in-water devices between Alternative 1 and Alternative 2, so the predicted impacts would be the same as described above in Section 3.4.2.4.1.1 (Impacts from Vessels and In-water Devices Under Alternative 1 for Vessel Movement) regarding impacts from vessels and in-water devices. Under Alternative 2, based on the analysis presented above, and the assumption that the populations for large whales in the NWTT Study Area are most likely to continue to increase as has generally been the trend in the recent past, the Navy is seeking authorization for a take to account for the possibility of an accidental strike and the potential risk associated with any military vessel movement within the Study Area. Under Alternative 2, the Navy will request authorization for mortality or serious injury from vessel strike over the seven-year period provided in this analysis for three ship strike takes, identical to the request for Alternative 1 to the following species as detailed above: fin whale, humpback whale, sperm whale, minke whale, and gray whale.

The use of vessels and in-water devices as described under Alternative 2 may result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of vessels and in-water devices, as described under Alternative 2, may affect ESA-listed marine mammals. The use of vessels and in-water devices would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.4.1.3 Impacts from Vessels and In-Water Devices Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct proposed at-sea training and testing activities in the Study Area. Vessels and in-water devices as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer vessels and in-water devices within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing Navy training and testing activities under the No Action Alternative would lessen the potential for impacts from vessels and in-water devices on individual marine mammals, but would not measurably improve the status of marine mammal populations or subpopulations.

3.4.2.4.2 Impacts from Military Expended Materials

For the analysis of impacts from military expended material as physical disturbance stressors, see Section 3.4.3.4.3 (Impacts from Military Expended Material) in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a). Since the 2015 NWTT Final EIS/OEIS, there has been no new or emergent science that would change in any way the rationale for the dismissal of impacts from military expended material as presented in the 2015 analyses. There have been no known instances of physical disturbance or strike to any marine mammals as a result of training and testing activities involving the use of military expended materials prior to or since the 2015 NWTT Final EIS/OEIS.

3.4.2.4.2.1 Impacts from Military Expended Material Under Alternative 1

Impacts from Military Expended Material Under Alternative 1 for Training Activities

Under Alternative 1 and as presented in Section 3.0 (Introduction), training activities using military expended materials will decrease in comparison to the 2015 NWTT Final EIS/OEIS (Tables 3.0-14 through 3.0-17). While the number of training activities using military expended material would change under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) remain valid; physical disturbance and strike impacts to marine mammals resulting from military expended materials are not expected.

The use of military expended material during training activities as described under Alternative 1 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of military expended material during training activities, as described under Alternative 1, may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA. The use of military expended material would have no effect on humpback whale proposed critical habitat and Southern Resident killer whale existing critical habitat or proposed critical habitat.

Impacts from Military Expended Material Under Alternative 1 for Testing Activities

Under Alternative 1 and as presented in Section 3.0 (Introduction), testing activities using military expended materials will decrease in comparison to the 2015 NWTT Final EIS/OEIS (Tables 3.0-14 through 3.0-17). While the number of testing activities using military expended material would change under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) remain valid; physical disturbance and strike impacts to marine mammals resulting from military expended materials are not expected.

The use of military expended material during testing activities as described under Alternative 1 would not result in the incidental taking of marine mammal.

Pursuant to the ESA, military expended material during testing activities, as described under Alternative 1, may affect ESA-listed marine mammals. The Navy will consult with NMFS as required by section 7(a)(2) of the ESA. The use of military expended material would have no effect on humpback whale proposed critical habitat and Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.4.2.2 Impacts from Military Expended Material Under Alternative 2

Impacts from Military Expended Material Under Alternative 2 for Training Activities

Under Alternative 2 and as presented in Section 3.0 (Introduction), training activities using military expended materials will increase in comparison to the 2015 NWTT Final EIS/OEIS and Alternative 1 (Tables 3.0-14 through 3.0-17). While the number of training activities using military expended material would change under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National

Oceanic and Atmospheric Administration, 2015a) remain valid; physical disturbance and strike impacts to marine mammals resulting from military expended materials are not expected.

The use of military expended material during training activities as described under Alternative 2 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of military expended material during training activities, as described under Alternative 2, may affect ESA listed marine mammals. The use of military expended material would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

Impacts from Military Expended Material Under Alternative 2 for Testing Activities

Under Alternative 2 and as presented in Section 3.0 (Introduction), testing activities using military expended materials will increase in comparison to the 2015 NWTT Final EIS/OEIS and Alternative 1 (Tables 3.0-14 through 3.0-17). While the number of testing activities using military expended material would change under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) remain valid; physical disturbance and strike impacts to marine mammals resulting from military expended materials are not expected.

The use of military expended material during testing activities as described under Alternative 2 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of military expended material during testing activities, as described under Alternative 2, may affect ESA-listed marine mammals. The use of military expended material would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.4.2.3 Impacts from Military Expended Material Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct proposed at-sea training and testing activities in the Study Area. Military expended material as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer military expended materials within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for impacts from military expended materials on individual marine mammals, but would not measurably improve the status of marine mammal populations or subpopulations.

3.4.2.4.3 Impacts from Seafloor Devices

For the analysis of impacts from seafloor devices as physical disturbance stressors, see Section 3.4.3.4.4 (Impacts from Seafloor Devices) in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a). Since the 2015 NWTT Final EIS/OEIS, there has been no new or emergent science that would change in any way the rationale for the dismissal of seafloor devices as presented in the 2015 analyses. There have been no known instances of physical disturbance or strike to any marine mammals as a result of training and testing activities involving the use of seafloor devices prior to or since the 2015 NWTT Final EIS/OEIS.

3.4.2.4.3.1 Impacts from Seafloor Devices Under Alternative 1

Impacts from Seafloor Devices Under Alternative 1 for Training Activities

Under Alternative 1 and as presented in Section 3.0 (Introduction), training activities that use seafloor devices will increase in comparison to the 2015 NWTT Final EIS/OEIS (Table 3.0-18). While the number of training activities using seafloor devices would change under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) remain valid; physical disturbance and strike impacts to marine mammals resulting from seafloor devices are not expected.

The use of seafloor devices during training activities as described under Alternative 1 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of seafloor devices during training activities, as described under Alternative 1, may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA. The use of seafloor devices would have no effect on humpback whale proposed critical habitat and Southern Resident killer whale existing critical habitat or proposed critical habitat.

Impacts from Seafloor Devices Under Alternative 1 for Testing Activities

Under Alternative 1 and as presented in Section 3.0 (Introduction), testing activities that use seafloor devices will increase in comparison to the 2015 NWTT Final EIS/OEIS (Table 3.0-18). While the number of testing activities using seafloor devices would change under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) remain valid; physical disturbance and strike impacts to marine mammals resulting from seafloor devices are not expected.

The use of seafloor devices during testing activities as described under Alternative 1 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of seafloor devices during testing activities, as described under Alternative 1, may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA. The use of seafloor devices would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.4.3.2 Impacts from Seafloor Devices Under Alternative 2

Impacts from Seafloor Devices Under Alternative 2 for Training Activities

Under Alternative 2 and as presented in Section 3.0 (Introduction), training activities that use seafloor devices will increase in comparison to the 2015 NWTT Final EIS/OEIS but are the same as proposed under Alternative 1 (Table 3.0-18). While the number of training activities using seafloor devices would change under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) remain valid; physical disturbance and strike impacts to marine mammals resulting from seafloor devices are not expected.

The use of seafloor devices during training activities as described under Alternative 2 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of seafloor devices during training activities, as described under Alternative 2, may affect ESA-listed marine mammals. The use of seafloor devices would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

Impacts from Seafloor Devices Under Alternative 2 for Testing Activities

Under Alternative 2 and as presented in Section 3.0 (Introduction), testing activities that use seafloor devices will increase in comparison to the 2015 NWTT Final EIS/OEIS and as proposed under Alternative 1 (Table 3.0-18). While the number of testing activities using seafloor devices would change under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) remain valid; physical disturbance and strike impacts to marine mammals resulting from seafloor devices are not expected.

The use of seafloor devices during testing activities as described under Alternative 2 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of seafloor during testing activities, as described under Alternative 2, may affect ESA-listed marine mammals. The use of seafloor devices would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.4.3.3 Impacts from Seafloor Devices Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct proposed at-sea training and testing activities in the Study Area. Seafloor devices as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer seafloor devices within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for impacts from seafloor devices on individual marine mammals, but would not measurably improve the status of marine mammal populations or subpopulations.

3.4.2.5 Entanglement Stressors

The entanglement stressors that may impact marine mammals include (1) wires and cables, (2) decelerators/parachutes, and (3) biodegradable polymer. Biodegradable polymer is a new sub-stressor not previously analyzed in the 2015 NWTT Final EIS/OEIS. For the analysis of wires and cables and decelerators/parachutes as entanglement stressors, see Section 3.4.3.5 (Entanglement Stressors) in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric

Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a).

3.4.2.5.1 Impacts from Wires and Cables

Wires and cables include fiber optic cables, guidance wires, and sonobuoy wires as detailed in Section 3.0 (Introduction) in this Supplemental and the 2015 NWTT Final EIS/OEIS. Since the 2015 NWTT Final EIS/OEIS, there has been no new or emergent science that would change in any way the rationale for the dismissal of wires and cables as presented in the 2015 analyses. There have been no known instances of entanglement of any marine mammals involving the use of wires and cables associated with Navy training and testing activities prior to or since the 2015 NWTT Final EIS/OEIS.

3.4.2.5.1.1 Impacts from Wires and Cables Under Alternative 1

Impacts from Wires and Cables Under Alternative 1 for Training Activities

Under Alternative 1 and as presented in Section 3.0 (Introduction), training activities that use wires and cables will increase in comparison to the 2015 NWTT Final EIS/OEIS (Table 3.0-19). While the number of training activities using wires and cables would increase as proposed under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) remains valid; entanglement impacts to marine mammals resulting from wires and cables associated with Navy activities are not expected.

The use of wires and cables during training activities as described under Alternative 1 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of wires and cables during training activities, as described under Alternative 1, may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA. The use of wires and cables would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

Impacts from Wires and Cables Under Alternative 1 for Testing Activities

Under Alternative 1 and as presented in Section 3.0 (Introduction), testing activities that use wires and cables will increase in comparison to the 2015 NWTT Final EIS/OEIS (Table 3.0-19). While the number of testing activities using wires and cables would increase under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) remains valid; entanglement impacts to marine mammals resulting from wires and cables associated with Navy activities are not expected.

The use of wires and cables during testing activities as described under Alternative 1 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of wires and cables during testing activities, as described under Alternative 1, may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA. The use of wires and cables would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.5.1.2 Impacts from Wires and Cables Under Alternative 2

Impacts from Wires and Cables Under Alternative 2 for Training Activities

Under Alternative 2 and as presented in Section 3.0 (Introduction), training activities that use wires and cables will increase in comparison to the 2015 NWTT Final EIS/OEIS and in comparison to Alternative 1 (Table 3.0-19). While the number of training activities using wires and cables would increase as proposed under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) remains valid; entanglement impacts to marine mammals resulting from wires and cables associated with Navy activities are not expected.

The use of wires and cables during training activities as described under Alternative 2 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of wires and cables during training activities, as described under Alternative 2, may affect ESA-listed marine mammals. The use of wires and cables would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

Impacts from Wires and Cables Under Alternative 2 for Testing Activities

Under Alternative 2 and as presented in Section 3.0 (Introduction), testing activities that use wires and cables will increase in comparison to the 2015 NWTT Final EIS/OEIS and in comparison to Alternative 1 (Table 3.0-19). While the number of testing activities using wires and cables would increase proposed under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) remains valid; entanglement impacts to marine mammals resulting from wires and cables associated with Navy activities are not expected.

The use of wires and cables during testing activities as described under Alternative 2 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of wires and cables during testing activities, as described under Alternative 2, may affect ESA-listed marine mammals. The use of wires and cables would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.5.1.3 Impacts from Wires and Cables Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct proposed at-sea training and testing activities in the Study Area. Wires and cables as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer wires and cables within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for impacts from wires and cables on individual marine mammals, but would not measurably improve the status of marine mammal populations or subpopulations.

3.4.2.5.2 Impacts from Decelerators/Parachute

Decelerators/parachutes are described in Section 3.0 (Introduction) in this Supplemental and the 2015 NWTT Final EIS/OEIS. Since the 2015 NWTT Final EIS/OEIS, there has been no new or emergent science that would change in any way the rationale for the dismissal of decelerators/parachutes as presented in the 2015 analyses. There have been no known instances of entanglement of any marine mammals as a result of Navy training and testing activities involving the use of decelerators/parachutes prior to or since the 2015 NWTT Final EIS/OEIS.

3.4.2.5.2.1 Impacts from Decelerators/Parachutes Under Alternative 1

Impacts from Decelerators/Parachutes Under Alternative 1 for Training Activities

Under Alternative 1 and as presented in Section 3.0 (Introduction), training activities that use decelerators/parachutes will increase in comparison to the 2015 NWTT Final EIS/OEIS (Table 3.0-20). While the number of training activities using decelerators/parachutes would increase as proposed under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) remains valid; entanglement impacts to marine mammals resulting from decelerators/parachutes associated with Navy activities are not expected.

The use of decelerators/parachutes during training activities as described under Alternative 1 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of decelerators/parachutes during training activities, as described under Alternative 1, may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA. The use of decelerators/parachutes would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

Impacts from Decelerators/Parachutes Under Alternative 1 for Testing Activities

Under Alternative 1 and as presented in Section 3.0 (Introduction), testing activities that use decelerators/parachutes will increase in comparison to the 2015 NWTT Final EIS/OEIS (Table 3.0-20). While the number of testing activities using decelerators/parachutes would increase as proposed under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) remains valid; entanglement impacts to marine mammals resulting from decelerators/parachutes associated with Navy activities are not expected.

The use of decelerators/parachutes during testing activities as described under Alternative 1 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of decelerators/parachutes during testing activities, as described under Alternative 1, may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA. The use of decelerators/parachutes would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.5.2.2 Impacts from Decelerators/Parachutes Under Alternative 2

Impacts from Decelerators/Parachutes Under Alternative 2 for Training Activities

Under Alternative 2 and as presented in Section 3.0 (Introduction), training activities that use decelerators/parachutes will increase in comparison to the 2015 NWTT Final EIS/OEIS and as proposed under Alternative 1 (Table 3.0-20). While the number of training activities using decelerators/parachutes would increase as proposed under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) remains valid; entanglement impacts to marine mammals resulting from decelerators/parachutes associated with Navy activities are not expected.

The use of decelerators/parachutes during training activities as described under Alternative 2 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of decelerators/parachutes during training activities, as described under Alternative 2, may affect ESA-listed marine mammals. The use of decelerators/parachutes would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

Impacts from Decelerators/Parachutes Under Alternative 2 for Testing Activities

Under Alternative 2 and as presented in Section 3.0 (Introduction), testing activities that use decelerators/parachutes will increase in comparison to the 2015 NWTT Final EIS/OEIS and as proposed under Alternative 1 (Table 3.0-20). While the number of testing activities using decelerators/parachutes would increase as proposed under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) remains valid; entanglement impacts to marine mammals resulting from decelerators/parachutes associated with Navy activities are not expected.

The use of decelerators/parachutes during testing activities as described under Alternative 2 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of decelerators/parachutes during testing activities, as described under Alternative 2, may affect ESA-listed marine mammals. The use of decelerators/parachutes would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.5.2.3 Impacts from Decelerators/Parachutes Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct proposed at-sea training and testing activities in the Study Area. Decelerators/parachutes as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer decelerators/parachutes within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for impacts from decelerators/parachutes on individual marine mammals, but would not measurably improve the status of marine mammal populations or subpopulations.

3.4.2.5.3 Impacts from Biodegradable Polymer

A new type of expended material is used during the existing countermeasure testing activity that involves the use of biodegradable polymers. The proposed use of biodegradable polymers in this Supplemental is in addition to other entanglement stressors that were previously analyzed in the 2015 NWTT Final EIS/OEIS. Marine vessel stopping payloads are systems designed to deliver the appropriate measure(s) to affect a vessel's propulsion and associated control surfaces to significantly slow and potentially stop the advance of the vessel. Marine vessel stopping proposed activities include the use of biodegradable polymers. The biodegradable polymers that the Navy uses are designed to temporarily interact with the propeller(s) of a target craft rendering the craft ineffective. Based on the constituents of the biodegradable polymer the Navy proposes to use, it is anticipated that the material will break down into small pieces within a few days to weeks. This will break down further and dissolve into the water column within weeks to a few months. The final products, which are all environmentally benign, will be dispersed quickly to undetectable concentrations. Unlike other entanglement stressors, biodegradable polymers only retain their strength for a relatively short period of time; therefore, the potential for entanglement by a marine mammal would be limited. Furthermore, the longer the biodegradable polymer remains in the water, the weaker it becomes, making it more brittle and likely to break. A marine mammal would have to encounter the biodegradable polymer immediately after it was expended for it to be a potential entanglement risk. If an animal were to encounter the polymer a few hours after it was expended, it is very likely that it would break easily and would no longer be an entanglement stressor.

3.4.2.5.3.1 Impacts from Biodegradable Polymers Under Alternative 1

Impacts from Biodegradable Polymers Under Alternative 1 for Training Activities

Biodegradable polymers would not be used during training activities under Alternative 1.

Impacts from Biodegradable Polymers Under Alternative 1 for Testing Activities

Biodegradable polymers were not part of the proposed action analyzed in the 2015 NWTT Final EIS/OEIS. Under Alternative 1 in this Supplemental and as presented in Section 3.0 (Introduction), testing activities that involve marine vessel stopping payloads using biodegradable polymer will occur in the Inland Waters portion of the Study Area a maximum of four times annually (Table 3.0-21). Marine mammals most likely to be present in the Dabob Bay Range Complex or at the Keyport Range are harbor porpoise, harbor seal, California sea lion, and Steller sea lion, although it is possible for any marine mammal species inhabiting the Inland Waters portion of the Study Area to be at either of those two locations.

As detailed for Southern Resident killer whales in Section 3.4.1.16.1 (Status and Management), the designated Southern Resident killer whale critical habitat includes most of the Inland Waters portion of the Study Area but does not include any of Hood Canal (where the Dabob Bay Range Complex is located), the Keyport Range Site, or waters shallower than 20 ft. (6.1 m) relative to the extreme high water tidal datum as detailed in (National Marine Fisheries Service, 2016h; National Marine Fisheries Service: Northwest Region, 2006). The primary constituent elements of the Southern Resident killer whale's critical habitat have been identified as (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging (National Marine Fisheries Service: Northwest Region, 2006). At the Keyport Range, there is only limited overlap between the periphery of the range site and the designated Southern Resident killer whale's critical habitat (National Marine Fisheries Service, 2010), but more importantly, none of the elements of the critical habitat should be impacted by the use of biodegradable polymers in those portions of the Keyport Range that do overlap the critical habitat.

The number of proposed testing activities involving biodegradable polymers in the Inland Waters is relatively low. Based on this limited number of annual activities, the concentration of biodegradable polymers within the two Inland Waters locations of the Study Area would likewise be low, and the Navy does not anticipate that any marine mammals would become entangled by biodegradable polymers.

The use of biodegradable polymers during testing activities as described under Alternative 1 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of biodegradable polymers during testing activities, as described under Alternative 1, may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA. The use of biodegradable polymers would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.5.3.2 Impacts from Biodegradable Polymers Under Alternative 2

Impacts from Biodegradable Polymers Under Alternative 2 for Training Activities

Biodegradable polymers would not be used during training activities under Alternative 2.

Impacts from Biodegradable Polymers Under Alternative 2 for Testing Activities

Biodegradable polymers were not part of the proposed action analyzed in the 2015 NWTT Final EIS/OEIS. The proposed use of biodegradable polymers under Alternative 2 in this Supplemental is the same as under Alternative 1 (see Table 3.0-21). As a result, the expected impacts are the same between the two alternatives and as described in detail above under Alternative 1; Navy does not anticipate that any marine mammals would become entangled by biodegradable polymers.

The use of biodegradable polymers during testing activities as described under Alternative 2 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of biodegradable polymers during testing activities, as described under Alternative 2, may affect ESA-listed marine mammals. The use of biodegradable polymers would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.5.3.3 Impacts from Biodegradable Polymers Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct proposed at-sea training and testing activities in the Study Area. Biodegradable polymers as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would remain unchanged after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer biodegradable polymers within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities would lessen the potential for impacts from biodegradable polymers on individual marine mammals, but would not measurably improve the status of marine mammal populations or subpopulations.

3.4.2.6 Ingestion Stressors

The ingestions stressors that may impact marine mammals include military expended materials from munitions (non-explosive practice munitions and fragments from high-explosives) and military expended materials other than munitions (fragments from targets, chaff and flare components, decelerators/parachutes, and biodegradable polymers) as detailed in Section 3.0.3.6 (Ingestion Stressors) in this Supplemental. Use of biodegradable polymer as part of an existing testing activity is a new ingestion stressor that was not previously analyzed in the 2015 NWTT Final EIS/OEIS, but it has been analyzed in this Supplemental as part of military expended materials – other than munitions.

3.4.2.6.1 Impacts from Military Expended Materials – Munitions

Ingestion impacts from military expended materials – munitions were analyzed in the 2015 NWTT Final EIS/OEIS and are discussed in this Supplemental in Section 3.0.3.6 (Ingestion Stressors). Since the 2015 NWTT Final EIS/OEIS, there has been no new or emergent science that would change in any way the analysis of military expended materials – munitions as ingestion stressors as discussed in the 2015 analyses. There have been no known instances of ingestion of military expended materials by any marine mammals prior to or since the 2015 NWTT Final EIS/OEIS.

3.4.2.6.1.1 Impacts from Military Expended Materials – Munitions Under Alternative 1

<u>Impacts from Military Expended Materials – Munitions Under Alternative 1 for Training Activities</u>

Under Alternative 1 and as presented in Section 3.0 (Introduction), Tables 3.0-14 and 3.0-16, training use of military expended materials – munitions will decrease in comparison to ongoing activities and as discussed in the 2015 NWTT Final EIS/OEIS. While training use of military expended material would change under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) would not change. NMFS determined that use of ingestion stressors would not result in the incidental taking of marine mammals pursuant to the MMPA and that the likelihood of ESA-listed species ingesting expended materials was so low as to be discountable and therefore was not likely to adversely affect ESA-listed species. Given that under Alternative 1, the use of military expended materials – munitions has decreased in comparison to the 2015 analyses, impacts to marine mammal from military expended materials – munitions as ingestion stressors is not expected.

The use of military expended materials – munitions during training activities as described under Alternative 1 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of military expended materials – munitions during training activities, as described under Alternative 1, may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA. The use of military expended materials – munitions would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

Impacts from Military Expended Materials – Munitions Under Alternative 1 for Testing Activities

Under Alternative 1 and as presented in Section 3.0 (Introduction), Tables 3.0-14 and 3.0-16, testing use of military expended materials – munitions will increase in comparison to ongoing activities and as discussed in the 2015 NWTT Final EIS/OEIS. While testing use of military expended material would change under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) would not change. NMFS determined that use of ingestion stressors would not result in the incidental taking of marine mammals pursuant to the MMPA and that the likelihood of ESA-listed species ingesting expended materials was so low as to be discountable and therefore was not likely to adversely affect ESA-listed species. Given that under Alternative 1, the use of military expended materials – munitions has decreased in comparison to the 2015 analyses, impacts to marine mammal from military expended materials – munitions as ingestion stressors is not expected.

The use of military expended materials – munitions during testing activities as described under Alternative 1 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of military expended materials – munitions during testing activities, as described under Alternative 1, may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA. The use of military expended materials – munitions would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.6.1.2 Impacts from Military Expended Materials – Munitions Under Alternative 2

Impacts from Military Expended Materials – Munitions Under Alternative 2 for Training Activities

Under Alternative 2 and as presented in Section 3.0 (Introduction), Tables 3.0-14 and 3.0-16, training use of military expended materials – munitions will increase slightly (by less than 1 percent) in comparison to ongoing activities and as discussed in the 2015 NWTT Final EIS/OEIS and proposed under Alternative 1. While training use of military expended material would change under this Supplemental, the analysis presented in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) would not change. NMFS determined that use of ingestion stressors would not result in the incidental taking of marine mammals pursuant to the MMPA and that the likelihood of ESA-listed species ingesting expended materials was so low as to be discountable and therefore was not likely to adversely affect ESA-listed species. Impacts as ingestion stressors from the use of military expended materials – munitions are not expected.

The use of military expended materials – munitions during training activities as described under Alternative 2 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of military expended materials – munitions during training activities, as described under Alternative 2, may affect ESA-listed marine mammals. The use of military expended materials – munitions would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

Impacts from Military Expended Materials – Munitions Under Alternative 2 for Testing Activities

Under Alternative 2 and as presented in Section 3.0 (Introduction), Tables 3.0-14 and 3.0-16, testing use of military expended materials – munitions will increase in comparison to ongoing activities and are the same as under Alternative 1 in this Supplemental. Given the alternatives are the same and as presented above for Alternative 1 for testing, impacts from ingestion stressors from the use of military expended materials – munitions are not expected.

The use of military expended materials – munitions during testing activities as described under Alternative 2 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of military expended materials – munitions during testing activities, as described under Alternative 2, may affect ESA-listed marine mammals. The use of military expended materials – munitions would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.6.1.3 Impacts from Military Expended Materials – Munitions Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct proposed at-sea training and testing activities in the Study Area. Military expended materials as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer military expended materials within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for impacts from military expended materials on individual marine mammals, but would not measurably improve the status of marine mammal populations or subpopulations.

3.4.2.6.2 Impacts from Military Expended Materials – Other than Munitions

There is a new type of expended material used during the existing countermeasure testing activity that involves the use of biodegradable polymers. The proposed use of biodegradable polymers for testing activities in this Supplemental is in addition to other ingestion stressors that were previously analyzed in the 2015 NWTT Final EIS/OEIS. For the analysis of all other military expended materials – other than munitions ingestion stressors, see Section 3.4.3.6 (Ingestion Stressors) in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a).

As stated in Section 3.0.3.5.3 (Biodegradable Polymer), based on the constituents of the biodegradable polymer the Navy proposes to use, it is anticipated that the material will break down into small pieces within a few days to weeks. This will break down further and dissolve into the water column within weeks to a few months. These small pieces will break down further and dissolve into the water column within weeks to a few months and could potentially be incidentally ingested by marine mammals. The final products, which are all environmentally benign, will be dispersed quickly to undetectable concentrations. Because the final products of the breakdown are all environmentally benign, the Navy does not expect the use of biodegradable polymer to have any negative impacts for marine mammals.

As detailed for Southern Resident killer whales in Section 3.4.1.16.1 (Status and Management), the designated Southern Resident killer whale critical habitat includes most of the Inland Waters portion of the Study Area, but does not include any of Hood Canal (where the Dabob Bay Range Complex is located) or the 18 DoD installations within Puget Sound as detailed in (National Marine Fisheries Service, 2016h; National Marine Fisheries Service: Northwest Region, 2006). The primary constituent elements of the Southern Resident killer whale's critical habitat have been identified as (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging (National Marine Fisheries Service: Northwest Region, 2006). At Keyport there may be some overlap with the designated critical habitat and the use of biological polymers, but none of the features of the critical habitat should be impacted by the use of biodegradable polymers at that location.

3.4.2.6.2.1 Impacts from Military Expended Materials – Other than Munitions Under Alternative 1

Impacts from Military Expended Materials – Other than Munitions Under Alternative 1 for Training Activities

Under Alternative 1 and as presented in Section 3.0 (Introduction), Tables 3.0-15, 3.0-17, 3.0-20, 3.0-21, and 3.0-22, training use of military expended materials – other than munitions will decrease in comparison to ongoing activities and as discussed in the 2015 NWTT Final EIS/OEIS. The new biodegradable polymers ingestion sub stressor would not be used during training activities under Alternative 1. While training use of military expended material would change under this Supplemental, the analysis presented in Section 3.4.3.6 (Ingestion Stressors) in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) would not change. NMFS determined that use of ingestion stressors would not result in the incidental taking of marine mammals pursuant to the MMPA and that the likelihood of ESA-listed species ingesting expended materials was so low as to be discountable and therefore was not likely to adversely affect ESA-listed species. Given that under Alternative 1, the use of military expended materials – other than munitions has decreased in comparison to the 2015 analyses, impacts to marine mammal from military expended materials – other than munitions as ingestion stressors is not expected.

The use of military expended materials – other than munitions during training activities as described under Alternative 1 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of military expended materials – other than munitions during training activities, as described under Alternative 1, may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA. The use of military expended materials – other than munitions would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

Impacts from Military Expended Materials – Other than Munitions Under Alternative 1 for Testing Activities

Under Alternative 1 and as presented in Section 3.0 (Introduction), Tables 3.0-15, 3.0-17, 3.0-20, 3.0-21, and 3.0-22, testing use of military expended materials – other than munitions will increase in comparison to ongoing activities and as discussed in the 2015 NWTT Final EIS/OEIS. This includes testing activities that use biodegradable polymers, which are proposed to be conducted in the Dabob Bay Range Complex and at the Keyport Range. Marine mammals most likely to be present in the Dabob Bay Range Complex or at Keyport are harbor porpoise, harbor seal, California sea lion, and Steller sea lion. The number of proposed testing activities involving biodegradable polymers is relatively low (a maximum of four times annually), as shown in Section 3.0.3.5.3 (Biodegradable Polymer), Table 3.0-21. In addition, biodegradable polymer fragments would only be temporarily available within the water column as they tend to disintegrate fairly quickly. Because the final products of the breakdown are all environmentally benign, the Navy does not expect the use biodegradable polymer to have any negative impacts for marine mammals. This Navy determination is also consistent with the recent NMFS findings regarding the use of biodegradable polymers in the Southern California Range Complex, as presented in 83 FR 66846 and National Marine Fisheries Service (2018b).

While training use of military expended material would change under this Supplemental, the analysis presented in Section 3.4.3.6 (Ingestion Stressors) in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) would not change. NMFS determined that use of ingestion stressors would not result in the incidental taking of marine mammals pursuant to the MMPA and that the likelihood of ESA-listed species ingesting expended materials was so low as to be discountable and therefore was not likely to adversely affect ESA-listed species. Therefore, impacts on marine mammals from ingestion stressors under Alternative 1 are not expected.

The use of military expended materials – other than munitions during testing activities as described under Alternative 1 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of military expended materials – other than munitions during testing activities, as described under Alternative 1, may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA. The use of military expended materials – other than munitions would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.6.2.2 Impacts from Military Expended Materials – Other than Munitions Under Alternative 2

Impacts from Military Expended Materials – Other than Munitions Under Alternative 2 for Training Activities

Under Alternative 2 and as presented in Section 3.0 (Introduction), Tables 3.0-15, 3.0-17, 3.0-20, 3.0-21, and 3.0-22, training use of military expended materials – other than munitions will slightly increase in comparison to ongoing activities and Alternative 1. The new biodegradable polymers ingestion sub stressor would not be used during training activities under Alternative 2. While training use of military expended material would change under this Supplemental, the analysis presented in Section 3.4.3.6 (Ingestion Stressors) in the 2015 NWTT Final EIS/OEIS, the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2015c; National Oceanic and Atmospheric Administration, 2015a) would not change. NMFS determined that use of ingestion stressors would not result in the incidental taking of marine mammals pursuant to the MMPA and that the likelihood of ESA-listed species ingesting expended materials was so low as to be discountable and therefore was not likely to adversely affect ESA-listed species. Impacts to marine mammal from military expended materials – other than munitions as ingestion stressors is not expected.

The use of military expended materials – other than munitions during training activities as described under Alternative 2 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of military expended materials – other than munitions during training activities, as described under Alternative 2, may affect ESA-listed marine mammals. The use of military expended materials – other than munitions would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

Impacts from Military Expended Materials – Other than Munitions Under Alternative 2 for Testing Activities

Under Alternative 2 and as presented in Section 3.0 (Introduction), Tables 3.0-15, 3.0-17, 3.0-20, 3.0-21, and 3.0-22, testing use of military expended materials – other than munitions will increase in comparison to ongoing activities and are the same as proposed under Alternative 1 in this Supplemental. Given the alternatives are the same and as presented above for Alternative 1 for testing, the conclusions are the same. Impacts from ingestion stressors from the use of military expended materials – other than munitions are not expected.

The use of military expended materials – other than munitions during testing activities as described under Alternative 2 would not result in the incidental taking of marine mammals.

Pursuant to the ESA, the use of military expended materials – other than munitions during testing activities, as described under Alternative 2, may affect ESA-listed marine mammals. The use of military expended materials – other than munitions would have no effect on humpback whale proposed critical habitat, or Southern Resident killer whale existing critical habitat or proposed critical habitat.

3.4.2.6.2.3 Impacts from Military Expended Materials – Other than Munitions Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct proposed at-sea training and testing activities in the Study Area. Military expended materials as listed above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Discontinuing the training and testing activities would result in fewer military expended materials within the marine environment where training and testing activities have historically been conducted. Therefore, discontinuing training and testing activities under the No Action Alternative would lessen the potential for impacts from military expended materials on individual marine mammals, but would not measurably improve the status of marine mammal populations or subpopulations.

3.4.2.7 Impacts from Secondary Stressors

As discussed in Section 3.4.3.7 (Impacts from Secondary Stressors) of the 2015 NWTT Final EIS/OEIS, secondary stressors from military training and testing activities were analyzed for potential indirect impacts on marine mammals via habitat degradation or an effect on prey availability. These stressors included (1) explosives, (2) explosive byproducts and unexploded ordnance, (3) metals, (4) chemicals, and (5) transmission of marine mammal diseases and parasites. Analyses of the potential impacts on sediments and water quality from the proposed training and testing activities were also discussed in detail in Section 3.1 (Sediments and Water Quality) of the 2015 NWTT Final EIS/OEIS. The analysis of explosives, explosive byproducts, metals, chemicals, and the transmission of diseases and parasites and their potential to indirectly impact marine mammals and their habitat has not appreciably changed from the presentation in the 2015 NWTT Final EIS/OEIS given the previous conclusions were not tied to the number of activities occurring, but to the nature of these stressors. The findings from multiple studies subsequent to the 2015 NWTT Final EIS/OEIS have reinforced the previous conclusion that the relatively low solubility of most explosives and their degradation products, metals, and chemicals means that concentrations of these contaminants in the marine environment, including those associated with either high-order or low-order detonations, are relatively low and readily diluted. For example, in the Study Area the concentration of unexploded ordnance, explosion byproducts, metals, and other chemicals would never exceed that of a World War II dump site. A series of studies of a World War II dump site off Hawaii have demonstrated only minimal concentrations of degradation products were detected in the adjacent sediments and that there was no detectable uptake in sampled organisms living on or in proximity to the site (Briggs et al., 2016; Carniel et al., 2019; Edwards et al., 2016; Hawaii Undersea Military Munitions Assessment, 2010; Kelley et al., 2016; Koide et al., 2016). It has also been documented that the degradation products of Royal Demolition Explosive are not toxic to marine organisms at realistic exposure levels (Lotufo, 2017; Rosen & Lotufo, 2010). Any remnant undetonated components from explosives such as TNT, royal demolition explosive, and high melting explosive experience rapid biological and photochemical degradation in marine systems (Carniel et al., 2019; Cruz-Uribe et al., 2007; Juhasz & Naidu, 2007; Pavlostathis & Jackson, 2002; Singh et al., 2009; Walker et al., 2006). As another example, the Canadian Forces Maritime Experimental and Test Ranges near Nanoose, British Columbia, began operating in 1965 conducting test events for both U.S. and Canadian forces, which included many of the same test events that are conducted in the NWTT Study Area. Environmental analyses of the impacts from years of testing at Nanoose were documented in 1996 and 2005 (Environmental Science Advisory Committee, 2005). These analyses concluded the Navy test activities "…had limited and perhaps negligible effects on the natural environment" (Environmental Science Advisory Committee, 2005). Based on these and other similar applicable findings from multiple Navy ranges as discussed in detail in Section 3.1 (Sediments and Water Quality) of this Supplemental, indirect impacts on marine mammals from the training and testing activities in the Study Area would be negligible and would have no long-term effect on habitat.

Secondary stressors from training and testing activities were analyzed for potential indirect impacts on marine mammal prey availability. Underwater explosions could impact other species in the food web, including prey species that marine mammals feed upon. The impacts of explosions would differ depending upon the type of prey species in the area of the detonation. A reduction in availability of prey may cause animals to forage for longer periods, travel to alternate locations, or abandon foraging efforts (National Oceanic and Atmospheric Administration, 2015b). However, there are other factors such as commercial fisheries or competition between species that have much greater and widespread effect than Navy activities. For example, Nelson et al. (2019) found significant correlation between the increase in the numbers of harbor seals since the 1970s and a 74 percent decrease in maximum sustainable yield in Chinook salmon for 14 of 20 wild Chinook populations, which are a main food source for the endangered Southern Resident killer whales.

In the 2015 analysis of training and testing within the Study Area, NMFS determined that secondary stressors would not result in harassment and/or the incidental taking of marine mammals from Navy training and testing activities (National Oceanic and Atmospheric Administration, 2015b) and that secondary stressors would not result in significant adverse impacts or jeopardize the continued existence of any ESA listed marine mammals (National Marine Fisheries Service, 2014). There has been no emergent science since that determination that would otherwise change the prior analysis.

3.4.3 Summary of Impacts (Combined Impacts of All Stressors)

As listed in Section 3.0.3 (Identification of Stressors for Analysis), this section evaluates the potential for combined impacts of all identified stressors resulting from the Proposed Action. The analysis and conclusions for the potential impacts from each of the individual stressors are discussed in Sections 3.4.2.1 (Acoustic Stressors) through 3.4.2.7 (Impacts from Secondary Stressors) and, for ESA-listed species, summarized in Section 3.4.4 (Endangered Species Act Determinations).

Understanding the combined effects of stressors on marine organisms in general and marine mammal populations in particular is extremely difficult to predict (National Academies of Sciences Engineering and Medicine, 2017a). Recognizing the difficulties with measuring trends in marine mammal populations, the focus has been on indicators for adverse impacts, including health and other population metrics (National Academies of Sciences Engineering and Medicine, 2017a). This recommended use of population indicators is the approach Navy presented in the 2015 NWTT Final EIS/OEIS Section 3.4.3 (Summary of Impacts [Combined Impacts of All Stressors] on Marine Mammals) and formed part of the 2015 analyses by NMFS in their MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2014).

Stressors associated with military readiness activities do not typically occur in isolation but rather occur in some combination. For example, mine neutralization activities include elements of acoustic, physical disturbance and strike, entanglement, ingestion, and secondary stressors that are all coincident in space and time. An analysis of the combined impacts of all stressors considers the potential consequences of additive stressors and synergistic stressors, as described below. This analysis makes the reasonable assumption, which is supported by the Navy Acoustic Effects Model, that the majority of exposures to stressors are non-lethal, and instead focuses on consequences potentially impacting marine mammal fitness (e.g., physiology, behavior, reproductive potential).

There are generally two ways that a marine mammal could be exposed to multiple additive stressors. The first would be if a marine mammal were exposed to multiple sources of stress from a single event or activity within a single event (e.g., a mine warfare event may include the use of a sound source and a vessel). The potential for a combination of these impacts from a single activity would depend on the range to effects of each of the stressors and the response or lack of response to that stressor. Most of the activities proposed under Alternative 1 generally involve the use of moving platforms (e.g., ships, torpedoes, and aircraft) that may produce one or more stressors; therefore, it is likely that if a marine mammal were within the potential impact range of those activities, it may be impacted by multiple stressors simultaneously. Individual stressors that would otherwise have minimal to no impact, may combine to have a measurable response. However, due to the wide dispersion of stressors, speed of the platforms, general dynamic movement of many military readiness activities, and behavioral avoidance exhibited by many marine mammal species, it is very unlikely that a marine mammal would remain in the potential impact range of multiple sources or sequential events. Exposure to multiple stressors is more likely to occur at an instrumented range where military readiness activities using multiple platforms may be concentrated during a particular event. In such cases involving a relatively small area on an instrumented range, a behavioral reaction resulting in avoidance of the immediate vicinity of the activity would reduce the likelihood of exposure to additional stressors. Nevertheless, the majority of the proposed activities are unit-level military readiness activities which are conducted in the open ocean. Unit-level events occur over a small spatial scale (one to a few square miles) and with few participants (usually one or two) or short duration (the order of a few hours or less); larger-scale training and testing events occur in other Navy training and testing locations (e.g., the Southern California Range Complex or the Hawaii Range Complex).

Secondly, a marine mammal could be exposed to multiple military readiness activities over the course of its life; however, military readiness activities are generally separated in space and time in such a way that it would be unlikely that any individual marine mammal would be exposed to stressors from multiple activities within a short timeframe. However, animals with a home range intersecting an area of concentrated Navy activity have elevated exposure risks relative to animals that simply transit the area through a migratory corridor.

Multiple stressors may also have synergistic effects. For example, marine mammals that experience temporary hearing loss or injury from acoustic stressors could be more susceptible to physical strike and disturbance stressors via a decreased ability to detect and avoid threats. Marine mammals that experience behavioral and physiological consequences of ingestion stressors could be more susceptible to entanglement and physical strike stressors via malnourishment and disorientation. These cumulative, synergistic, and antagonistic interactions between multiple stressors, both natural and anthropogenic, have just begun to be investigated, and the exact mechanisms each stressor contributes to individual fitness is poorly understood. To date, the majority of scientific investigations on this topic have been on marine mammals (Murray et al., 2020; National Academies of Sciences Engineering and Medicine, 2017b; National Marine Fisheries Service, 2018a). Based on current best available science, the effects of multiple synergistic stressors over time cannot be realistically or precisely modeled for marine mammals. The Navy's quantitative and qualitative analyses are consistently conservative and likely over-predict impacts on marine mammals.

Research and monitoring efforts have included before, during, and after-event observations and surveys, data collection through conducting long-term studies in areas of Navy activity, occurrence surveys over large geographic areas, biopsy of animals occurring in areas of Navy activity, and tagging studies where animals are exposed to Navy stressors. These efforts are intended to contribute to the overall understanding of what impacts may be occurring overall to animals in these areas. To date, the findings from the research and monitoring and the regulatory conclusions from previous analyses by NMFS in the MMPA authorization (National Oceanic and Atmospheric Administration, 2015b) and the NMFS Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2014) have been that the majority of impacts from military readiness activities are not expected to have deleterious impacts on the fitness of any individuals or long-term consequences to populations of marine mammals and not likely to jeopardize listed species or destroy or adversely modify critical habitat.

3.4.3.1 Combined Impacts of All Stressors Under Alternative 1

Although potential impacts on certain marine mammal species from military readiness activities under Alternative 1 may include injury to individuals, those injuries are not expected to lead to long-term consequences for populations. The potential impacts anticipated from Alternative 1 are summarized in Sections 3.4.4 (Endangered Species Act Determinations) and 3.4.5 (Marine Mammal Protection Act Determinations) for each regulation applicable to marine mammals. For a discussion of cumulative impacts, see Chapter 4 (Cumulative Impacts). For a discussion of mitigation, see Chapter 5 (Mitigation).

3.4.3.2 Combined Impacts of All Stressors Under Alternative 2

As detailed previously in this section, some military readiness activities proposed under Alternative 2 would be an increase over what is proposed for Alternative 1. However, this increase is not expected to significantly increase the potential for impacts over what is analyzed for Alternative 1. The analysis presented in Section 3.4.3.1 (Combined Impacts of All Stressors Under Alternative 1) would similarly apply to Alternative 2. The combined Impacts of all stressors for military readiness activities under Alternative 2 are not expected to have deleterious impacts or long-term consequences to populations of marine mammals.

3.4.3.3 Combined Impacts of All Stressors Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct proposed at-sea training and testing activities in the Study Area. The stressors described above would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.4.3.4 Summary of Monitoring and Observations During Navy Activities Since 2015

As provided in detail in the 2015 NWTT Final EIS/OEIS Section 3.4.4.1 (Summary of Monitoring and Observations During Navy Activities), the results of previous monitoring and research since 2006 taking place in and around Navy ranges and occurring before, during, and after navy training and testing events, has been included as part of the Navy analyses as well as the analyses by NMFS in their MMPA authorization (National Oceanic and Atmospheric Administration, 2015b), and the Biological Opinion for the 2015 NWTT Final EIS/OEIS (National Marine Fisheries Service, 2014).

It has long been recognized that even when multiple years of marine mammal survey data are available for analysis, our ability to assess the magnitude and direction of trends in the abundance of individual marine mammal populations can be limited (Forney, 2000; Forney et al., 1991; Gerrodette, 1987; Moore & Barlow, 2017; Moore & Barlow, 2014; Taylor et al., 2007). For example, even for waters off the U.S. West Coast that have relatively good survey coverage over multiple decades, it cannot be conclusively determined if the sperm whale population in this region is increasing, decreasing, or has remained static (Moore & Barlow, 2017). Additional types of information must therefore be considered when assessing the likely impacts of Navy activities on marine mammal populations.

Since 2006, the Navy, non-Navy marine mammal scientists, and research groups and institutions have conducted scientific monitoring and research in and around ocean areas in the Atlantic and Pacific where the Navy has been and proposes to continue training and testing. The analysis provided in this Supplemental will be the third time Navy training and testing activities at-sea have been comprehensively analyzed in the Study Area. Data collected from Navy monitoring, scientific research findings, and annual reports have been provided to NMFS, and this public[8] record is informative as part of the analysis of impacts to marine mammals in general for a variety of reasons, including species distribution, habitat use, and evaluation of potential responses to Navy activities.

Monitoring is performed using a variety of methods, including visual surveys from surface vessels and aircraft, as well as passive acoustics before, during, and after Navy activities have been conducted. The

[8] Navy monitoring reports are available at the Navy website; (www.navymarinespeciesmonitoring.us/) and also at the NMFS website (https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-military-readiness-activities).

Navy also has continued to contribute to funding of basic research, including behavioral response studies specifically designed to determine the effects to marine mammals from the Navy's main mid-frequency surface ship anti-submarine warfare sonar and other acoustic sources of potential impact.

The majority of the training and testing activities Navy is proposing for the foreseeable future in the Study Area are similar if not nearly identical to activities that have been occurring in the same locations for decades. For example, the mid-frequency sonar system on the destroyers homeported in the Study Area has the same sonar system components in the water as those first deployed in the 1970s. While the signal analysis and computing processes onboard these ships have been upgraded with modern technology, the sonar transducers, which puts signals into the water, have not changed. For this reason, the history of past marine mammal observations, research, and monitoring reports remain applicable to the analysis of effects from the proposed future training and testing activities.

It is still the case that in the Pacific, the vast majority of scientific field work, research, and monitoring efforts have been expended in Southern California and Hawaii, where Navy training and testing activities have been more concentrated. Since 2006, the Navy has been submitting exercise reports and monitoring reports to NMFS for the Navy's range complexes in the Pacific and the Atlantic. These publicly available exercise reports, monitoring reports, and the associated research findings have been integrated into adaptive management decisions regarding the focus for subsequent research and monitoring as determined in collaborations between Navy, NMFS, Marine Mammal Commission, and other marine resource subject matter experts using an adaptive management approach. For example, see the 2017 U.S. Navy Annual Marine Species Monitoring Report for the Pacific that was made available to the public in April 2018 (U.S. Department of the Navy, 2018a).

In the Study Area, there are no Major Exercises, training and testing events are by comparison to other Navy areas less frequent and are in general small in scope, so as a result the majority of Navy's research effort has been focused elsewhere. Since the 2015 NWTT Final EIS/OEIS, research funded by Navy in the Pacific Northwest has included but is not limited to the following:

- Passive acoustic monitoring, tagging, and data analysis modeling to understand the offshore distribution of Southern Resident killer whales in the Pacific Northwest as executed by the National Marine Fisheries Service Northwest Fisheries Science Center and the Marine Physical Laboratory at Scripps Institution of Oceanography (Emmons et al., 2019b; Hanson et al., 2018; Hanson et al., 2015, 2017; Rice et al., 2017).
- Marine mammal aerial surveys covering the Inland Waters of Puget Sound to better derive the abundance, distribution, and density of populations of marine mammals inhabiting that area. This work was a Navy-funded collaboration between Smultea Environmental Services, National Marine Fisheries Service Alaska Fisheries Science Center, and the Washington Department of Fish & Wildlife (Jefferson et al., 2017; Jefferson et al., 2016; Smultea et al., 2015; Smultea et al., 2017).
- The Pacific Northwest pinniped satellite tracking study performed by National Marine Fisheries Service Alaska Fisheries Science Center and the Washington Department of Fish and Wildlife involved affixing data tags on pinnipeds at Naval Base Bangor, Naval Base Bremerton, Naval Station Everett to establish the baseline habitat movements, distribution, and seasonal use (DeLong et al., 2017).

- Four years of fieldwork involving photo-identification, biopsy, visual survey, and satellite tagging of blue, fin, and humpback whales were undertaken by Oregon State University. This research provided seasonal movement tracks, distribution, and behavior of these species in addition to biopsy samples used for sex determination and individual identifications, as well as stock structure information (Mate et al., 2017; Mate et al., 2018; U.S. Department of the Navy, 2018a).
- Continued deployment of passive acoustic recorders (Ecological Acoustic Recorders - EARS) in the waters of Washington State to monitor marine mammal vocalizations (Emmons et al., 2019b; Rice et al., 2015a; Rice et al., 2017; Trickey et al., 2015)
- Deployment of an autonomous passive-acoustic glider survey in the Quinault Range Site off the Washington coast to test the general functionality of the technology for cetacean density estimation (Klinck et al., 2015).

As detailed in the 2015 NWTT Final EIS/OEIS, these reporting, monitoring, and research efforts have added to the baseline data for marine mammals inhabiting the Study Area. In addition, subsequent research and monitoring has continued to broaden the sample of observations regarding the general health of marine mammal populations in locations where Navy has been conducting training and testing activities for decades, which has been considered in the analysis of marine mammal impacts presented in this Supplemental in the same manner that the previous findings were used in the 2015 NWTT Final EIS/OEIS, the NMFS authorization of takes under MMPA (National Oceanic and Atmospheric Administration, 2015b), and the NMFS Biological Opinion pursuant to the ESA (National Marine Fisheries Service, 2014).

This public record of training and testing activities, monitoring, and research from across the Navy range complexes in the Pacific and Atlantic now spans more than 13 years. Given that this record involves many of the same Navy training and testing activities being considered for the Study Area, includes all the marine mammal taxonomic families present in the Study Area, many of the same species, and some of the same populations as they seasonally migrate from other range complexes, this compendium of Navy reporting is directly applicable to the Study Area.

It was the Navy's assessment in the 2015 NWTT Final EIS/OEIS and that of NMFS as reflected in their analysis of previous Navy training and testing in the Study Area (National Marine Fisheries Service, 2014; National Oceanic and Atmospheric Administration, 2015b), that it was unlikely there would be impacts to populations of marine mammals (such as whales, dolphins, and pinnipeds) having any long-term consequences as a result of the proposed continuation of training and testing in the Study Area. This assessment of likelihood is based on four indicators from areas in the Pacific where Navy training and testing has been ongoing for decades: (1) evidence suggesting or documenting increases in the numbers of marine mammals present, (2) examples of documented presence and site fidelity of species and long-term residence by individual animals of some species, (3) use of training and testing areas for breeding and nursing activities, and (4) 13 years of comprehensive monitoring data indicating a lack of any observable effects to marine mammal populations such as direct mortalities or strandings occurring as a result of Navy training and testing activities. Consistent with the presentation in the 2015 NWTT Final EIS/OEIS, the evidence from Navy range complexes to date and since 2015 continues to suggest the viability of marine mammal populations where Navy trains and tests, and an absence of any direct evidence suggesting Navy training and testing has had or may have any long-term consequences to marine mammal populations. Barring any evidence to the contrary, therefore, what limited evidence there is from the monitoring reports and additional other focused scientific investigations should be considered in the analysis of impacts to marine mammals. For the NWTT Study Area in particular and since the analysis in 2015, examples include:

- the most current information suggesting that the ESA-listed blue whale population in the Pacific, which includes the NWTT Study Area as part of their habitat, may have recovered and been at a stable level based on recent surveys and scientific findings (Barlow, 2016; Campbell et al., 2015; Carretta et al., 2019c; Carretta et al., 2017c; Monnahan et al., 2015; Rockwood et al., 2017; Širović et al., 2015b; Valdivia et al., 2019);
- an increase in sei whales off the Washington and Oregon coast in recent years, with more groups of sei whales sighted in the most recent NMFS survey than in all previous NMFS surveys combined (Barlow, 2016);
- the population of Guadalupe fur seals, which is listed as threatened under the ESA, has been growing and has been expanding their range to include the Pacific Northwest, where they were primarily known only from stranding records and archeological evidence (Aurioles-Gamboa & Camacho-Rios, 2007; Etnier, 2002; Hernández-Camacho & Trites, 2018; Lambourn et al., 2012; National Marine Fisheries Service, 2017a; Norris, 2017a; Rick et al., 2009);
- trend analysis and survey data indicate that the California stock of harbor seals in the NWTT Study Area is at carrying capacity (Carretta et al., 2019c; Carretta et al., 2017d; DeLong & Jeffries, 2017);
- multi-year aerial surveys in Puget Sound, in the Strait of Juan de Fuca, and the San Juan Islands have observed the reoccupation and recovery of harbor porpoises in those waters since the 1970s (Carretta et al., 2019c; Carretta et al., 2017c; Huggins et al., 2015; Jefferson et al., 2016);
- increases in the numbers of the Pacific Coast Feeding Group of gray whales seasonally feeding along the northern Washington coast and the Strait of Juan de Fuca (Scordino et al., 2017); and
- the increasing number of fin whales seen since 1999 between Vancouver Island and Washington state, "… may reflect recovery of the local populations in the North Pacific" (Towers et al., 2018b).

To summarize and bring up to date the findings from the 2015 NWTT Final EIS/OEIS based on the best available science, the evidence from reporting, monitoring, and research over more than a decade indicates that while the Proposed Action will result in harassment of marine mammals and may include injury to some individuals, these impacts are expected to be inconsequential at the level of their marine mammal populations. There is no direct evidence that routine Navy training and testing spanning decades has negatively impacted marine mammal populations at any Navy Range Complex or the NWTT Study Area. In fact for some of the most intensively used Navy training and testing areas in the Pacific, evidence such as the continued multi-year presence of long-term resident individual animals and small populations (Baird, 2018; Baird et al., 2015; Baird et al., 2017; Baird et al., 2018; Baird et al., 2016; Schorr et al., 2014; Schorr et al., 2018, 2019; U.S. Department of the Navy, 2017d), resident females documented with and without calves from year to year, and high abundances on the Navy ranges for some species in comparison to other off-range locations (DiMarzio et al., 2019; Moore & Barlow, 2017; Schorr et al., 2018, 2019; U.S. Department of the Navy, 2017d) provide indications of generally healthy marine mammal populations. It therefore remains that based on the best available science, including data developed in exercise and monitoring reports submitted to NMFS for more than a decade, that long-term consequences for marine mammal populations are unlikely to result from Navy training and testing activities in the Study Area.

3.4.4 Endangered Species Act Determinations

Pursuant to the ESA, the Navy has determined that the activities presented in this Supplemental may affect the North Pacific right whale, blue whale, fin whale, Western North Pacific gray whale, Mexico DPS humpback whale, Central America DPS humpback whale, sei whale, sperm whale, Eastern North Pacific Southern Resident killer whale, Guadalupe fur seal, and Western DPS Steller sea lion. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA for these listed species. The Navy has also determined that Navy training and testing activities may overlap designated critical habitat, as defined by the ESA, for the Eastern North Pacific Southern Resident killer whale, the proposed expansion of that critical habitat, and the proposed humpback whale critical habitat. The Navy will consult with NMFS as required by section 7(a)(2) of the ESA with regard to these determinations.

3.4.5 Marine Mammal Protection Act Determinations

The Navy is seeking a Letter of Authorization in accordance with the MMPA from NMFS for the use of certain stressors (the use of sonar and other transducers, explosives, and vessels), as described under the Preferred Alternative (Alternative 1). The use of sonar and other transducers may result in Level A and Level B harassment of certain marine mammals. The use of explosives may result in Level A harassment and Level B harassment of certain marine mammals. The use of vessels may result in Level A harassment or mortality due to potential physical strike. Refer to Section 3.4.2. 1.2 (Impacts from Sonar and Other Transducers) for details on the estimated impacts from sonar and other transducers, Section 3.4.2.2.2 (Impacts from Explosives) for impacts from explosives, and Section 3.4.2.4.1 (Impacts from Vessel and In-Water Devices) for details on the estimated impacts from vessels.

Based on the previous analyses for the same actions in NWTT as presented in the 2015 NWTT Final EIS/OEIS, consistent with the current MMPA authorization for Navy training and testing in the NWTT Study Area (National Oceanic and Atmospheric Administration, 2015b), and consistent with recent determinations for the same activities in other locations where Navy trains and tests,[9] the Navy has determined that weapon noise, vessel noise, aircraft noise, the use of in-water electromagnetic devices, in-air electromagnetic devices, high-energy lasers, in-water devices, seafloor devices, wires and cables, decelerators/parachutes, biodegradable polymers, and military expended materials are not expected to result in Level A or Level B harassment of any marine mammals.

[9] Conclusions in this regard refer to the findings reached by the Navy and NMFS for many of the same actions in Southern California and Hawaii (FR 83[247]:66846-67031; December 27, 2018).

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